900 063

INSTRUCTION AND MAINTENANCE MANUAL

FOR

SERIES 401 & 407

AC POWER CONTROLLERS

WITH PHASE ANGLE CONTROL

MP MASTER
MA32126

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1.0 PART NUMBERS AND GENERAL DRAWING NUMBERS

1.1 The units covered by this manual have part numbers of the form 401 XXX, 407 XXX, 401 XXX-X or 407 XXX-X; e.g., 401 246-5 and 407 308. The outline drawing number is the same as the part number. Unless noted otherwise, all paragraphs in this manual apply equally to the 401 and 407 series. Units designed for RF generator operation are covered in another manual.

2.0 INTRODUCTION

2.1 The Series 401 and 407 SCR Power Controllers provide solid state phase angle control of AC power. The SCR's (thyristors) serve as solid state switches which, when closed, apply line voltage to the load. In phase angle control, each SCR is turned on for a controlled portion of a half-cycle of the line voltage. The effective voltage (hence power) is determined by the portion of the line voltage delivered. The load voltage can then be varied by selecting the firing time of each SCR.

2.2 The Series 407 Power Controllers are identical to the Series 401 except that the Series 407 controllers are water cooled.

3.0 POWER REQUIREMENTS

3.1 (See nameplate.) All units are rated for nominal value of line ±10% @ 50 or 60 Hz. Standard ratings are 120V, 240V, 277V, 480V, 600V (60 Hz) and 240V, 380V, 415V (50 Hz) Units shut down automatically if line voltage drops below 70% of nominal value. Normal operation will return with recovery of line voltage. Three phase units will also shut down automatically if the input line voltages are unbalanced by more than 20% or if the phase sequence is reversed. Normal operation will resume with the application of a balanced, positive sequence (A,B,C) 3 phase AC supply.

4.0 LOAD RATINGS

4.1 RMS load voltage is controllable from zero to 96% of line voltage. Linearity is ±2% of full output voltage from 5% to 96% of the input voltage.

4.2 Refer to the nameplate for current rating. RMS load current rating is for continuous operation in free air at ambient temperatures of 50°C (122°F) or less, or with the specified supply of cooling water. The KVA ratings listed for these panels are approximate only and should not be used to calculate the current rating.

The load resistance should be such that under conditions of maximum line voltage, the nameplate current rating is not exceeded. Units for operation above 50°C are available on special order. See section 7.11, page 6. Typical momentary overload capability is 300% of RMS nameplate rating for 10 cycles.

4.3 These units may be operated into resistive or inductive loads driven either directly or through an interposing transformer or variable autotransformer. Three-phase units are designed to drive balanced, 3-wire, wye or delta connected loads when the coupling transformer is a Scott T or a true 3Ø transformer having all of the windings on a common core. Special care must be taken when driving a 3Ø autotransformer having 3 separate cores because the coupling between cores which facilitates resetting with slight load unbalance is absent. In some cases, these loads must be separated and driven by three single-phase units. Three-phase transformer applications require Automatic Balance Compensation (refer to 4.6).

4.4 Special precautions are necessary to limit peak inrush currents when these units are driving capacitive or tungsten lamp loads. An example of the former type of load is a rectifier bridge with large amounts of filtering. Units having a "-5" as the part number suffix have a 4-second ramp built in to limit the rate of rise of the output voltage to prevent firing into a cold load. These units are intended for operation into high-inrush loads.

4.5 All units use current limiting Amp-Trap Form 101 fuses. Replace only with fuses of identical type, voltage rating and current rating. In the event of a fuse failure with transformer coupled loads, the recommended practice is to replace all controller fuses because of the possibility of weakened links.

4.6 For 3Ø transformer coupled loads, special Gate Trigger Units are recommended. These drivers (gate trigger units) provide automatic balance compensation by varying the individual firing angles. Specify by suffix "-11" after basic panel part number. Part number 304 087-XX is the basic ABC gate trigger unit.

4.7 A number of current limiters are available. In certain applications with high temperature heating elements such as Platinum, Tungsten, or Molybdenum, current limiting is needed. These loads, when cold, draw 10 to 15 times the current drawn when hot. Under initial starting conditions, the cold load could draw enough

current to blow fuses, even after the initial "soft start" action of the controller is completed. Models 359 101 and 359 105 sense the load current through CT's and inhibit the driver when the current exceeds the preset value. These units are connected between the driver and the control signal. Model 359 101 is for single-phase controllers; model 359 105 is for three-phase controllers and acts on the highest of the three currents sensed. Models 359 101 and 359 105 are intended for use when the load can draw greater than 250% of rated current. A high performance limiter 300 236 is recommended for very high inrush loads such as tungsten or molybdenum base elements. Single-phase 401 units of 220 Ampere or less are available with an internal limiter and CT ("-2" suffix to the part number). These limiters are not connected between the command inputs and the power controller; the command inputs remain connected to the power controller. A chop-off limiter, model 359 027, is available for use with Series 401 or 407 controllers controlling RF generators in induction heating or as an electronic fuse. With short load faults or with arc-back from mercury vapor tubes, the 359 027 turns off the controller. During extended faults, a relay on the limiter picks up for interlocking with the main breaker. The 359 027 may be used with 1Ø or 3Ø controllers. Further information on these limiters may be found in Robicon bulletin 2.02B.

5.0 CONTROL REQUIREMENTS

5.1 Unit may be controlled with remote manual 3K ohm potentiometer. See Figure 1, page 15.

5.2 Unit may be controlled by an external voltage signal delivering 0-6V DC to 0-19V DC into 3K ohms. See Figure 2, page 15. The full range of control may be adjusted by the gain control.

5.3 Unit may be controlled by instruments delivering 0-5 mA, 2-12 mA, 4-20 mA or 10-50 mA into various terminating impedances. See table on page 16.

6.0 METERING

6.1 The typical AC meters encountered are usually not designed to provide meaningful readings of waveforms encountered in phase angle controlled SCR circuits. The relationship between the average value and the RMS or "heating" value is neither constant nor linear. Even though many AC meters have their scales labelled "RMS Amps" or "RMS Volts", most of them assume the

waveform being measured is a pure sinusoidal wave (single frequency). The most meaningful characterization of any AC waveform is its power or work value. The definition of RMS or effective value is the equivalent DC voltage required to do the same work as the AC voltage being measured.

6.2 Recommended meters: An RF type (thermocouple) or iron vane repulsion meter with good frequency response will give the most accurate RMS readings. For 60 Hz (cycles per second) work, the meter should accept frequencies from 60 Hz to 1000 Hz with the desired accuracy.

7.0 INSTALLATION AND OPERATION

7.1 Installation Precautions

7.11 Series 401 only. These air cooled panels are rated for operation in ambients of 50°C (122°F) maximum. They should be mounted with heat sinks vertical in open air spaces. If the panels are mounted in spaces with restricted air flow, precautions should be taken to ensure an ambient of less than 50°C. The same precautions apply to the special units rated above 50°C. Special units are rated at nameplate current above 50°C. Derating factor for these special units is 1.43% per C° up to 65°C.

7.12 Series 401 fan cooled. Fan cooled units are equipped with a thermal switch which detects excessive heat sink temperature. It is connected to disable the GTU when tripped.

7.13 Series 407 water cooled units. These units are equipped with a thermal switch which detects excessive heat sink temperature and disables the GTU when tripped. They must be connected to a source of water meeting the minimum flow rate recommended on the outline drawing. The following discussion of water supply quality has been taken from paragraph 4.2.1 from Application Note 200.50 published by General Electric Company, Semiconductor Products Department. There is additional information in this note on Corrosion Retardation in closed water systems.

1. If pure water, such as distilled water, steam condensate, or deionized water is used, the resistivity should be greater than 30,000 ohm-cm.

2. Tap water should meet the following specs:

   a) Slightly alkaline, pH 7.0 to 9.0.

   b) Resistivity greater than 2,000 ohm-cm at 25°C.

   c) Chloride content less than 20 parts per million, sulphate content less than 250 parts per million, total solids content less than 100 parts per million.

   d) Total hardness as calcium carbonate less than 250 parts per million.

7.2 Power Connections

7.21 Single-phase units. Connect one side of the load to T1. Connect one side of the line to L1. Connect the other side of the line to the remaining side of the load and run a separate lead from this junction to screw terminal L2. This is for control purposes only. Make sure all connections are tight. Observe the outline drawing for special instructions for running the input or output lead through the current transformer(s), if required.

7.22 Three-phase units. Connect the three incoming lines in positive phase sequence to A, B, and C. Connect the three load connections to T1, T2, and T3.

Observe the outline drawing for special instructions for running the input or output leads through current transformers, if required. Tighten all connections.

7.3 Control Connections

Refer to the outline drawing for any special instructions which may be specified in addition to those given in this section. Insure that thermal switch (fan cooled units) is connected into command circuit.

7.31 Manual Control - Remote Potentiometer. (See Figure 1, page 15) Connect the remote 3K ohm potentiometer to the gate trigger unit as follows: Connect the clockwise end of the pot to terminal #7, the wiper to terminal #3, and the counter-clockwise end to terminal #1. Clockwise rotation will increase output. The resistance of the pot should be between 3K ohms and 10K ohms, although values up to 50K ohms may be used with reduced control linearity.

7.32 Voltage Control. (See Figure 2, Page 15) Connect the positive end of a variable voltage source to terminal #1 of the G.T.U. and the negative end to terminal #3. The unit will accommodate sources from 0-6 Volts to 0-19V DC. The input resistance is 3K ohms.

7.33 Current Control. (See Figure 3, Page 15 and Table, Page 16) Connect the positive end of a variable current source to terminal #1 of the G.T.U. Refer to Table on Page 16 and Figure 3 on Page 15 for the negative connection and required jumper(s).

7.34 Special current control connections. Input current ranges and input resistance values other than those shown in the Table are obtainable with external resistance networks which will deliver 0-6 mA nominal (20 mA max.) to terminals #1 and #2. Input voltage drop across these terminals is one transistor base to emitter voltage of 0.6 to 0.8V DC.

7.4 Operational Adjustments - Bias and Gain

Units are precalibrated to the instrument if advised prior to shipment of its characteristics. Otherwise calibration will be 0-5 mA which is identical to remote potentiometer calibration. Calibration procedures below are given for troubleshooting only. Do not attempt to recalibrate a new unit needlessly.

7.41 Calibration Check. Connect an AC voltmeter across output and DC milliampere meter in series with instrument. A load must be applied to power controller. If current limiting is used, a light load is required to avoid interaction with the limiter. Apply power and run controlling instrument from its minimum to maximum level noting minimum and maximum outputs from the 401. If calibration is necessary, see below.

7.42 Bias Adjustment. With power and load applied, adjust control signal or manual potentiometer to the lowest setting that is required (e.g., 4 mA on a 4-20 mA instrument) and adjust the Bias control until the output voltage drops to zero.

7.43 Gain Adjustment. Apply full control signal or manual potentiometer (e.g., 20 mA on a 4-20 mA instrument) and adjust the Gain control until the output voltage reaches maximum, approximately 96% of line voltage.

8.0 MAINTENANCE

8.1 Periodic Inspection

8.11 It is important that the controller be kept clean. A layer of dust or process waste will reduce the heat transferring properties of the heat sinks and bus bars. It is recommended that the dust be blown off periodically. The power controller must be protected from metallic or conductive particles.

8.12 All panels subjected to corrosive atmosphere should have the electrical connections periodically inspected. Tarnished connections should be cleaned and joint compound reapplied. Alcoa No. 2 Joint Compound has been applied at the factory to all copper to aluminum bus bar connections and is recommended for field reapplication. Refer to the instructions on the can for proper joint preparation.

8.2 Component Replacement

If any electrical components are unfastened during inspection or during trouble shooting, prepare the mating surfaces as follows:

All fuse ends and bus bar connections should be cleaned according to the instructions with Alcoa No. 2 Joint Compound before the compound is applied. Semiconductors such as diodes and SCR's (thyristors) should be treated with Wakefield #120 Thermal Joint Compound according to the manufacturer's instructions.

8.3 Additional instructions for water cooled units (Series 407):

Hose connections should be checked for leaks. If any connectors are replaced, use fittings of the original material. To prevent electrolysis, adjacent fittings must be plastic or rubber or similar metals. Hoses should be checked for accumulations of debris which may block passageways.

9.0 TROUBLE SHOOTING

The following checks can be made with a multimeter. Replacement of SCR's and fuses can be made in the field, but if the trouble is ascribed to the Gate Trigger Unit, the GTU must be returned to the factory. Refer to Section 8.2 before replacing any electrical components. Section 9.1 is for Series 407 water cooled units only; Section 9.2 is for Series 401 air cooled units only; the remaining sections are general.

WARNING

EXPOSED BUS-BARS, HEAT SINKS, AND MANY TERMINALS ON THE GATE TRIGGER UNIT (DRIVER) INCLUDING GTU TERMINALS 11-12, 13-14, AND 15-16 WHICH ARE SCR (GATE-CATHODE) CONNECTIONS ARE AT FULL LINE POTENTIAL. ALWAYS DE-ENERGIZE THE PANEL BEFORE CONNECTING OR DISCONNECTING ANY METERS OR WIRING. BE EXTREMELY WARY OF METER LEADS WHICH MAY POP OFF OR SLIP AND SHORT TOGETHER OR SHORT TO OTHER TERMINALS. ALWAYS WORK WITH ONE HAND AND WEAR SAFETY GLASSES. DO NOT WORK ALONE. DO NOT CONNECT ANY NON-ISOLATED METERS OR OSCILLOSCOPES TO THE PANEL. CAREFULLY RECHECK ALL WIRING BEFORE APPLYING POWER.

9.1 Symptom: Series 407 (water cooled panels) No output.

Probable Cause: Loss of water circulation.

Remedy: Check hose connections. Inspect hoses for clogging material. Check water pressure. These units are equipped with a thermostat which disables the driver when the unit overheats. If hose replacement is necessary, do not use metallic sheath hose.

9.2 Symptom: Series 401 (fan cooled panels) No output.

Probable Cause: Loss of air pressure.

Remedy: Check fan for proper operation. These units are equipped with a thermostat which disables the driver when the heat sink temperature is excessive.

9.3 Symptom: No output.

Probable Cause: No input.

Remedy: Check for rated input voltage. For three-phase units, check for positive phase sequence (A,B,C). Reverse any two input leads.

Probable Cause: Incorrect wiring of external circuit.

Remedy: Check for proper load connections. For single-phase units, check for connection from load to terminal L2. (This is not a load connection.) See Section 7.2.

Symptom: No output.

Probable Cause: Incorrect bias setting or input signal.

Remedy: Check settings as per Section 7.4 and readjust, if necessary.

Probable Cause: Blown fuses.

Remedy: Open power to controller. Disconnect one end of each suspected fuse and check resistance with ohm-meter. It should measure less than 1 ohm. Replace, if necessary, with SAME TYPE. DO NOT INSTALL ANY OTHER TYPE OF FUSE. Measure load resistance (with panel disconnected) and make sure that panel is not being used beyond its rated current. Check for high input voltage. The safest practice on a fuse blow is to replace all fuses because of the possibility of weakened links on fuses that test "good".

9.4 Symptom: Full output or lack of control.

Probable Cause: Bias, gain, or input signal too high.

Remedy: Check settings as per Section 7.4 and re-adjust, if necessary. Refer to Table on page 16 for bias and gain limits. If turning gain control to max. CCW position does not cause output to decrease, input signal or bias is too high. With input signal disconnected, turning bias control CCW should cause output to decrease.

Probable Cause: Malfunctioning diodes.

Remedy: Disconnect one end of each suspected diode and measure resistance with ohm-meter leads connected both ways. Unit should read high (1 million ohms or greater) with the arrow point positive and low (5 to 15 ohms) with the arrow point negative. If diode reads essentially zero with both polarities, diode is shorted; if high, diode is open. Replace if necessary.

Symptom: Full output or lack of control.

Probable Cause: Malfunctioning SCR's.

Remedy: Disconnect the two leads of a suspected SCR (or fasten the case and remove one lead). The heavy gauge lead is the cathode, the lighter gauge lead is the gate and the case is the anode. Check the resistance readings for conformity to the following table:

Anode	Cathode	Gate	Ohm-Meter Reading
Open	Neg.	Pos.	5 to 100 ohms
Open	Pos.	Neg.	40 ohms or greater
Pos.	Neg.	Open	1 megohm or greater
Neg.	Pos.	Open	1 megohm or greater
Pos.	Both Negative		1 megohm or greater
Neg.	Both Positive		1 megohm or greater

Because of manufacturing differences an SCR not conforming to this table may be good and an SCR conforming may be defective. In the latter case, the SCR could be breaking down (shorting) when exposed to rated voltage. The only way to test for this in the field is to substitute an SCR known to be good. If the symptoms are cleared, the replaced SCR was defective.

9.5 Symptom: (Single-phase only)
Panel runs initially, then control from half output to zero output is lost. Panel cannot be turned off. Normal operation is regained after unit is allowed to cool.

Probable Cause: Poor heat conduction path from one SCR to heat sink causing the device to overheat and lose its voltage blocking capabilities.

Remedy: Make sure all SCR's are fastened securely to their heat sinks. Reapply joint compound if necessary (see Section 8.2). Replace SCR if this does not correct the problem.

9.6 Symptom: Output non-linearity.

Probable Cause: Improper operation on the GTU.

Remedy: Make the following tests on the GTU. With both the bias and gain controls maximum CCW, there should be no output from the GTU.

DO THE FOLLOWING WITH ALL POWER OFF:

Disconnect leads #11, 12, 13, 14, 15 and 16 (where present).
CAUTION: DO NOT ALLOW ANY LEADS TO TOUCH EACH OTHER OR THE PANEL. TAPE THE LEADS. DO NOT CONNECT ANY GROUNDED INSTRUMENTS TO THESE TERMINALS.
Apply power to the unit. With a 0-10V DC meter measure output pairs 11-12, 13-14 (15-16 also on three-phase units). Bias and gain controls maximum CW, read the outputs again. The meter reading should be steady at 4-6V DC. If reading fluctuates or is zero on any output, unit is defective. Consult the factory. Be sure input voltage is correct in magnitude and phase sequence, outputs are not being shorted, and input is disconnected before judging unit defective. Do not attempt to repair the gate trigger unit. If the unit seems okay, turn off the power, reconnect the leads to the proper terminals and make the following linearity test.

9.7 CAUTION: Do not replace SCR's or power diodes without torque and remount instructions from the factory.

10.0 SYSTEM CHECKING

10.1 System check for non-linearities:

Assuming the panel output can be controlled from full OFF to full ON, proceed as follows:

10.11 Monitor the panel output with an appropriate meter of known type (see Section 6.0).

10.12 Monitor the control input using a voltmeter for voltage control, a milliammeter for current control or a calibrated potentiometer for manual control as required. Set the bias and gain controls as previously described in Section 7.4.

10.13 With the power ON and the meters connected, adjust control to 100% (full output). The meters should read 100% current or voltage as determined by load and input voltage. See the graph on Page 17.

10.14 Check for conformity to the graph at various control inputs between full ON and full OFF. The control-input relationship should follow the curve given for the type of meter being used. Most multimeters such as those made by Simpson, Triplett, etc., are average reading meters. Full ON will be approximately 98% of the incoming line voltage when read by a true RMS responding meter and approximately 96% of the incoming line voltage when read by an averaging meter.

10.15 For 3Ø units equipped with Automatic Balance Compensation the load voltages should be reasonably matched because of the ABC circuit even though the load is not balanced at outputs of 20%-80% of ratings.

11.0 INTERLOCKS AND SHUTDOWN

11.1 The control circuitry of Series 401 and 407 controllers may be interlocked quite simply with either a NO or NC contact.

11.2 If a normally closed (NC) contact is available, connect it in series with the command input. This would be in the arm of the manual pot or one output line of a controlling instrument. The controller will shut down (to zero output) when the contact is reclosed. If a P/N 359 101 or P/N 359 105 current limiter is used, merely interrupt the command in the same fashion as above to the limiter.

11.3 If a normally open (NO) contact is available, connect it across terminals 1 and 2 of the GTU or 8 and 7 of the current limiter, if used. Closing this contact will cause the controller to shut down. The controller will resume normal operation when the contact is opened.

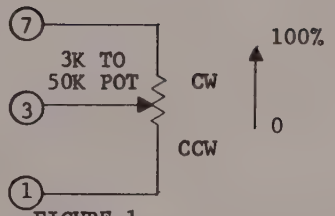


FIGURE 1
REMOTE CONTROL
WITH MANUAL POT

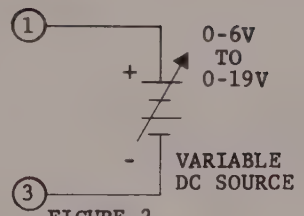


FIGURE 2
CONTROL WITH DC
VOLTAGE SOURCE

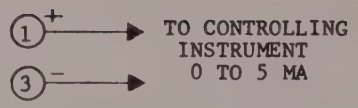
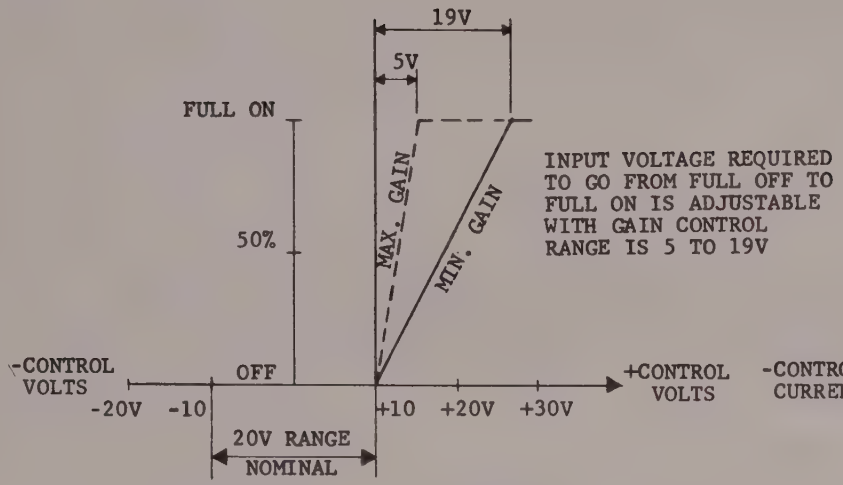


FIGURE 3
TYPICAL CURRENT CONTROL
SEE LINE 1 OF CHART ON
NEXT PAGE



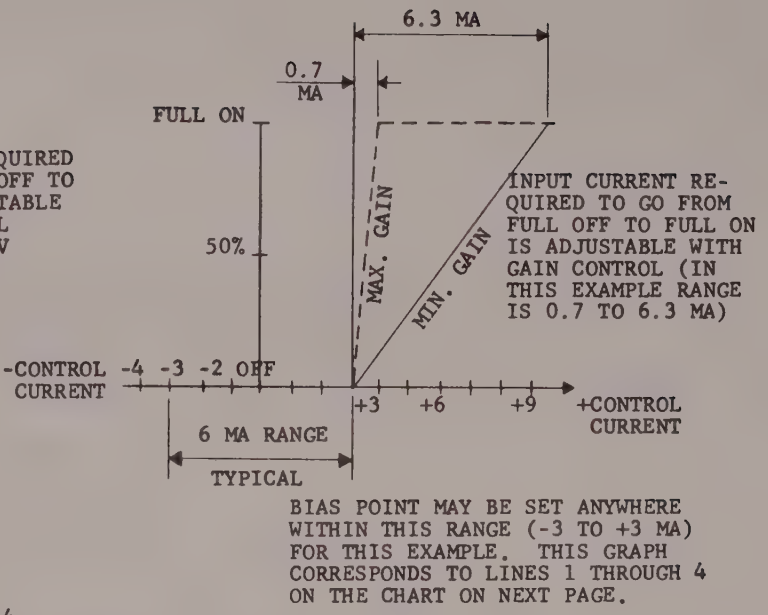


FIGURE 4

TYPICAL VOLTAGE TRANSFER
CURVE (LEFT) AND CURRENT
TRANSFER CURVE (RIGHT)

LINE	INPUT CONTROL CURRENT MA F.S.	DESIRED INPUT RESISTANCE OHM	INPUT CONNECTIONS TERM. #1 POSITIVE	JUMP TERMINALS	MAXIMUM INPUT CURRENT MA	MINIMUM BIAS ADJ. MA	TYPICAL BIAS ADJ. MA	CONTROL CURRENT RANGE FROM FULL ON TO FULL OFF MIN. MA	MAX. MA
1	5	2K	1 & 4	2 TO 3	16	± 2.7	± 3	0.7	6.3
2	5	3K	1 & 3	------	13	± 2.7	± 3	0.7	6.3
3	5	4K	1 & 5	3 TO 4	13	± 2.7	± 3	0.7	6.3
4	6	4K	1 & 5	3 TO 4	13	± 2.7	± 3	0.7	6.3
5	12	1.5K	1 & 3	1 TO 5	27	± 5.25	± 6	1.5	12.4
6	20	0.75K	1 & 3	1 TO 5 3 TO 4	40	± 9.8	±11	2.8	23
7	20	1.2K	1 & 4	1 TO 6	42	± 9.5	±11	2.7	22
8	50	0.6K	1 & 5	1 TO 6	73	±23.8	±28	6.5	54

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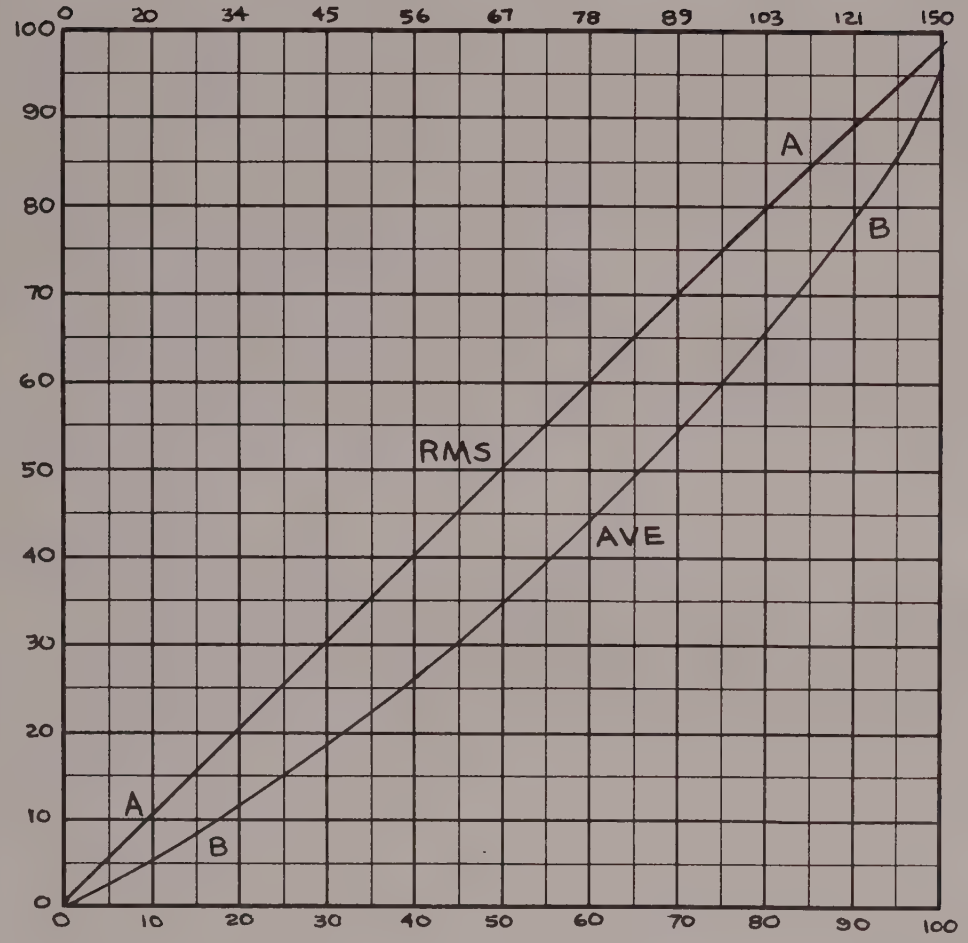
NOTE: BIAS CONTROL ADJUSTS FULL OFF POINT
GAIN CONTROL ADJUSTS FULL ON POINT
FOR TYPICAL TRANSFER CURVE FOR LINE #L, SEE PREVIOUS PAGE.

APPROXIMATE CONDUCTION ANGLE



VOLTAGE SCALES

(Top number in each column is A.C. line voltage)

600	480	240	120
540	432	216	108
480	384	192	96
420	336	168	84
360	288	144	72
300	240	120	60
240	192	96	48
180	144	72	36
120	96	48	24
60	48	24	12
0	0	0	0

NOTES: Curve A-A is for true RMS responding meters such as iron vane, thermocouple, etc.
Curve B-B is for average responding (rectifier type) meters such as Simpson 260, etc.

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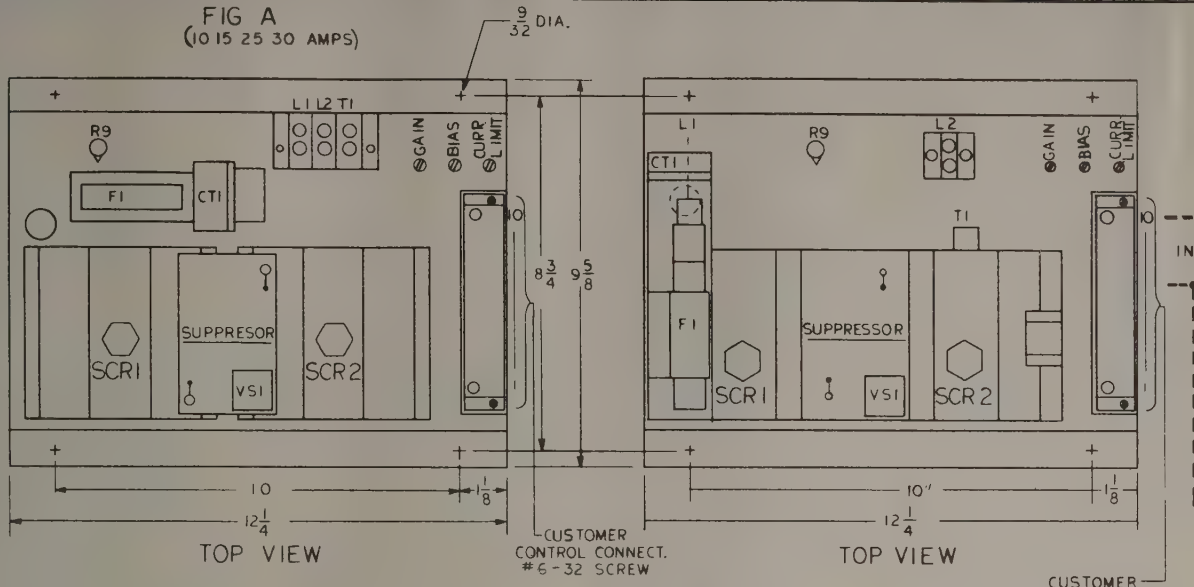
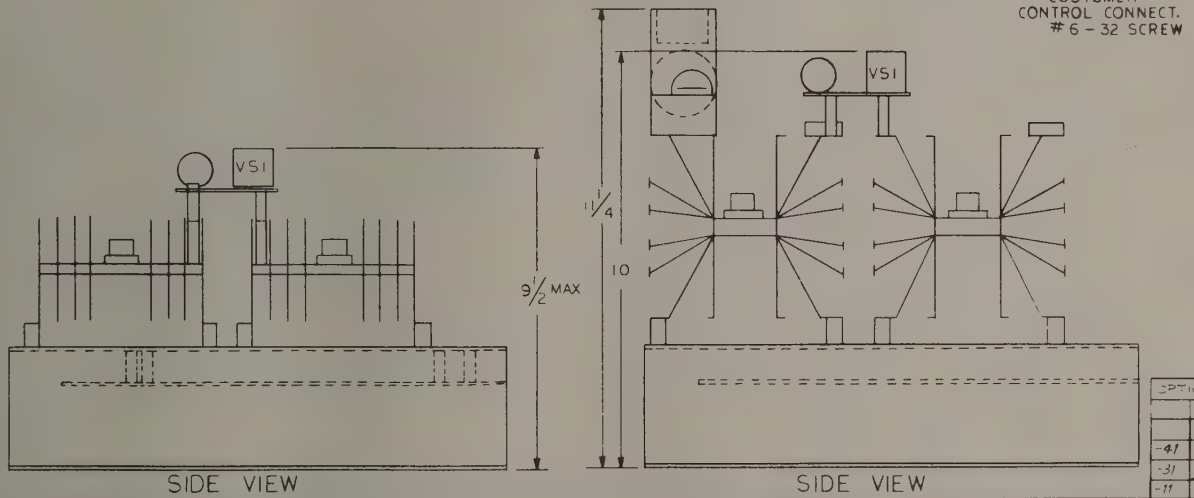
FIG A
(10 15 25 30 AMPS)





PART NO.	INPUT VOLT.	CURRENT	MAX. OUTPUT POWER (KVA)	FIG. NO.	CUSTOMER CONN L1 T1 L2	SCR	THYRECTOR	C1	FUSE	R9
401142	120 AC	10A	1 2	A		C20C	V130LA20B	.1uF 600V	A25X12	1.5K 2W
401642	208 AC	10A	2.1			C20E	V275LA40B	1uF 1000V	A25X12	5K 10W
401242	240 AC	10A	2 4			C20E	V275LA40B	1uF 1000V	A25X12	5K 10W
401443	277 AC	15A	4.2			202M	V320LA40B	.1uF 1000V	KAC 20	5K 10W
401343	480 AC	15A	7.2		#8-32 SCREW	202Z	V510LB80B	.1uF 3000V	KAC 20	10K 50W
401344	480 AC	25A	12			201Z	V510LB80B	1uF 3000V	KAC 30	10K 50W
401144	120 AC	30A	3.6			C30C	V130LA20B	1uF 600V	A25X30	1.5K 2W
401644	208 AC	30A	6.2			C30E	V275LA40B	1uF 1000V	A25X30	5K 10W
401244	240 AC	30A	7 2			C30E	V275LA40B	1uF 1000V	A25X30	5K 10W
401444	277 AC	30A	8.3	A		2N3899	V320LA40B	.1uF 1000V	KAC 30	5K 10W
401145	120 AC	77A	9 2	B		251F	V130LA20B	1uF 600V	A50P90	1.5K 2W
401645	208 AC	77A	16.0			251K	V275LA40B	1uF 1000V	A50P90	5K 10W
401245	240 AC	77A	18 5			251K	V275LA40B	1uF 1000V	A50P90	5K 10W
401445	277 AC	77A	21.3		#8-32 SCREW	251M	V320LA40B	.1uF 1000V	A50P90	5K 10W
401345	480 AC	77A	37.0			251Z	V510LB80B	1uF 3000V	A50P90	10K 50W
401146	120 AC	100A	12 0			250F	V130LA20B	1uF 600V	A50P125	1.5K 2W
401646	208 AC	100A	21.0			250K	V275LA40B	1uF 1000V	A50P125	5K 10W
401246	240 AC	100A	24.0		PRESSURE LUG #0 #12 AWG	250K	V275LA40B	1uF 1000V	A50P125	5K 10W
401446	277 AC	100A	27.7			250M	V320LA40B	1uF 1000V	A50P125	5K 10W
401346	480 AC	100A	48.0	B		250Z	V510LB80B	1uF 3000V	A50P125	10K 50W
401544	600 AC	25A	15.0	A		2N5207	(2) V320LA40B	1uF 700V	KAC 30	12K 50W
401545	600 AC	77A	46 2	B		251ZD	(2) V320LA40B	1uF 700V	A70P90	12K 50W
401844	DASH 1 THRU DASH8 415 V 50HZ	25A	380V UNIT = 9.5 415V UNIT = 16.6	A		201Z	V510LB80B	.1uF 3000V	KAC 30	10K 50W
401845	DASH 11 THRU DASH 18 330V 50HZ	77A	380V UNIT = 24.3 418V UNIT = 31.9	B		251Z	V510LB80B	1uF 3000V	A50P90	10K 50W
401846		100A	380V UNIT = 33 418V UNIT = 41.5	B		250Z	V510LB80B	.1uF 3000V	A50P125	10K 50W
401543	600AC	15A	600V UNIT 15AMP	A		2N5207	(2) V320LA40B	.1uF 700V	KAC 20	12K 50W

OPTIONAL

	C2	-52
-41		
-31	12	-34
-11	11	-12
21	23	24
-1		-2

WITHOUT CURRENT LIMIT

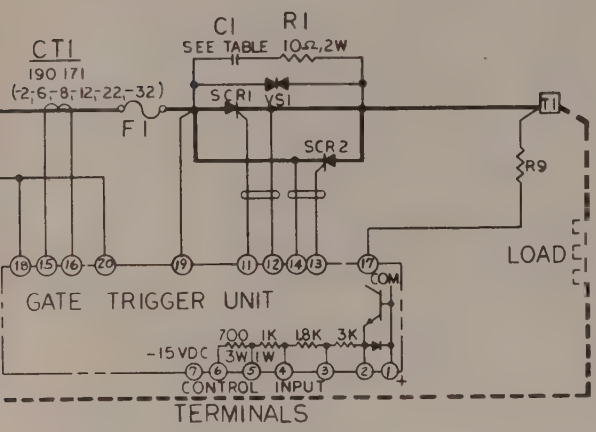
WITH CURRENT LIMIT

CONT SHT

SHT NO

DWG NO 401 100

REV



NOTES FOR SERIES 401:

1. THE SERIES 401 SINGLE PHASE SCR POWER CONTROLLERS PROVIDE SOLID STATE PHASE ANGLE CONTROL OF AC POWER. THE SCR'S (THYRISTORS) SERVE AS SOLID STATE SWITCHES WHICH, WHEN CLOSED, APPLY LINE VOLTAGE TO THE LOAD. IN PHASE ANGLE CONTROL, EACH SCR IS TURNED ON FOR A CONTROLLED PORTION OF A HALF CYCLE OF THE LINE VOLTAGE. THE EFFECTIVE VOLTAGE (HENCE, POWER) IS DETERMINED BY THE PORTION OF THE LINE VOLTAGE DELIVERED. THE LOAD VOLTAGE CAN THEN BE VARIED BY SELECTING THE FIRING TIME OF EACH SCR.
   THESE UNITS MAY BE OPERATED INTO RESISTIVE OR INDUCTIVE LOADS DRIVEN EITHER DIRECTLY OR THROUGH AN INTERPOSING TRANSFORMER OR VARIABLE AUTOTRANSFORMER.
   SPECIAL PRECAUTIONS ARE NECESSARY TO LIMIT PEAK INRUSH CURRENTS WHEN THESE UNITS ARE DRIVING CAPACITIVE OR TUNGSTEN LAMP LOADS. AN EXAMPLE OF THE FORMER TYPE OF LOAD IS A RECTIFIER BRIDGE WITH LARGE AMOUNTS OF FILTERING. UNITS HAVING A -5 AS THE PART NUMBER SUFFIX HAVE A 4 SECOND RAMP BUILT IN TO LIMIT THE RATE OF RISE OF THE OUTPUT VOLTAGE TO PREVENT FIRING INTO A COLD LOAD. THESE UNITS ARE INTENDED FOR OPERATION INTO HIGH INRUSH LOADS.

2. POWER CONNECTIONS:
   CHECK INFORMATION IN TABLE 1 FOR VOLTAGE AND CURRENT RATINGS AND TERMINAL LUG INFORMATION.
   CONNECT ONE SIDE OF THE LOAD TO T1. CONNECT ONE SIDE OF THE LINE TO L1. CONNECT THE OTHER SIDE OF THE LINE TO THE REMAINING SIDE OF THE LOAD AND RUN A SEPARATE LEAD FROM THIS JUNCTION TO SCREW TERMINAL L2. THIS IS FOR CONTROL PURPOSES ONLY. MAKE SURE ALL CONNECTIONS ARE TIGHT.
   ALL UNITS ARE RATED FOR NOMINAL VALUE OF LINE ±10%, 60 Hz. STANDARD RATINGS ARE 120V,208V,240V,277V,& 480V. UNITS SHUT DOWN AUTOMATICALLY IF LINE VOLTAGE DROPS BELOW 70% OF NOMINAL VALUE. NORMAL OPERATION WILL RETURN WITH RECOVERY OF LINE VOLTAGE.
   RMS LOAD VOLTAGE IS CONTROLLABLE FROM ZERO TO 96% OF LINE VOLTAGE. LINEARITY IS ±2% OF FULL OUTPUT VOLTAGE FROM 5% TO 96% OF THE INPUT VOLTAGE.
   REFER TO THE NAMEPLATE FOR CURRENT RATING. RMS LOAD CURRENT RATING IS FOR CONTINUOUS OPERATION IN FREE AIR AT AMBIENT TEMPERATURES OF 50°C (122°F) OR LESS. THE KVA RATINGS LISTED FOR THESE PANELS ARE APPROXIMATE ONLY AND SHOULD NOT BE USED TO CALCULATE THE CURRENT RATING. THE LOAD RESISTANCE SHOULD BE SUCH THAT UNDER CONDITIONS OF MAXIMUM LINE VOLTAGE THE NAMEPLATE CURRENT RATING IS NOT EXCEEDED. UNITS FOR OPERATION AT 50% RATED CURRENT AT 85°C ARE AVAILABLE ON SPECIAL ORDER.
   TYPICAL MOMENTARY OVERLOAD CAPABILITY IS 300% OF RMS NAMEPLATE RATING FOR 10 CYCLES.

3. CONTROL INPUT CONNECTIONS:
   (A) AUTOMATIC CONTROL
   CONNECT POSITIVE TO TERM. 1. CONNECT NEGATIVE TO APPROPRIATE TERMINAL FOR AVAILABLE CONTROL INPUT SIGNAL.

INPUT CONNECTION	NEGATIVE INPUT TERMINAL	NOMINAL RANGE	INPUT RESISTANCE	MAX. ALLOWABLE CURRENT
A_{100}	2	0-5 mA	100 OHMS	20 mA
A_{3000}	3	1-5 mA	3000 OHMS	12 mA
A_{5000}	4	1-5 mA	5000 OHMS	12 mA
B	4*	4-20 mA	1200 OHMS	40 mA
C	5*	10-50 mA	600 OHMS	70 mA
D (FOR -21,-22,-25)	3**	2-12 mA	1500 OHMS	27 mA

   FOR INPUT CONNECTION B OR C, JUMPER TERM. 6 TO TERM. 1.
   FOR INPUT CONNECTION D, JUMPER TERM. 5 TO TERM. 1.
   (B) MANUAL CONTROL - CONNECT 3000 OHM, 1/2W POTENTIOMETER AS FOLLOWS:

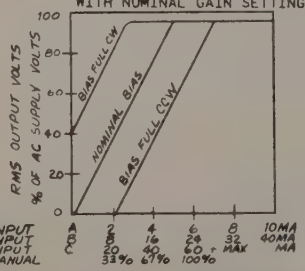
   OTHER INPUT RANGES AND INPUT RESISTANCE VALUES OBTAINABLE WITH COMBINATIONS OF INTERNAL AND/OR EXTERNAL RESISTORS. CONTROL MAY BE APPLIED OF OPPOSITE POLARITY AS SHOWN. IN ANY CASE, CURRENT THROUGH CONTROL WINDING MUST NOT EXCEED 20 mA.
   (C) TERMINALS - #6-32 SCREW CONNECTION.

4. DIELECTRIC TEST VOLTAGES:

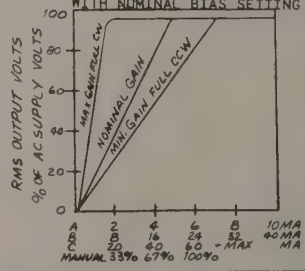
	INPUT VOLTAGE RATING					
	120	208	240	277	480	VAC NOM.
CONTROL CIRCUIT TO GROUND	1000	1000	1000	1000	1000	VAC MIN.
POWER CIRCUIT TO CONTROL CIRCUIT	1900	1500	1500	1600	2000	VAC MIN.
POWER CIRCUIT TO GROUND	1500	1500	1500	1600	2000	VAC MIN.

5. GAIN AND BIAS CONTROLS: GAIN AND BIAS ARE FACTORY SET AT NOMINAL SETTINGS AS INDICATED BELOW (0-5 mA NOMINAL RANGE).

TYPICAL BIAS CHARACTERISTICS WITH NOMINAL GAIN SETTING



TYPICAL GAIN CHARACTERISTICS WITH NOMINAL BIAS SETTING



SH NO & SUFFIX			
			REMOTE CURR LIMIT
			THERMAL SWITCH ADDED TO HEATSINK
			50HZ SUPPLY VOLTAGE INPUT 1-6MA @ 10KΩ
-16	-17	-18	50HZ SUPPLY VOLTAGE
FOR INPUT SEE 3-D			
-6	-7	-8	60HZ SUPPLY VOLTAGE (EXCEPT P/N 401844 AND P/N 401855 WHICH ARE ALL 50HZ.)
WITH CURRENT LIMIT, LONG RAMP	WITHOUT CURRENT LIMIT, FAST RAMP	WITH CURRENT LIMIT, FAST RAMP	

REMOTE CURRENT LIMIT

REDRAW	SCALE 1/2=1	Robicon Corporation, A BARBER COLMAN COMPANY	TITLE: SCR POWER CONTROLLER 401 INDUSTRIAL SERIES
	DATE 1-26-79		
	DRAWN RO		
	REVIEW MGJ	CUSTOMER	DWG NO 401 100 REVISION
	CHECK		
	APPROVE RSK	WORK ORDER	CONT ON SHT 2 SHT NO 1

PART NO.	INPUT VOLT.	CURRENT	MAX. OUTPUT POWER (KVA)	FIG. NO.	CUSTOMER CONN.				
					L1,T1	L2		SCR	T
401 843	415 AC	15A	6.25	A	#8-32	#8-32		202Z	V
401 546	600V	100A	60.0	B	#0-14AWG PRES.LUG.	#8-32		250ZD	V32

REVISIONS		
A	CHANGED THYRECTOR NO. R-BRACKET#677	
B	ADDED 401546 A/B 10-8-76	

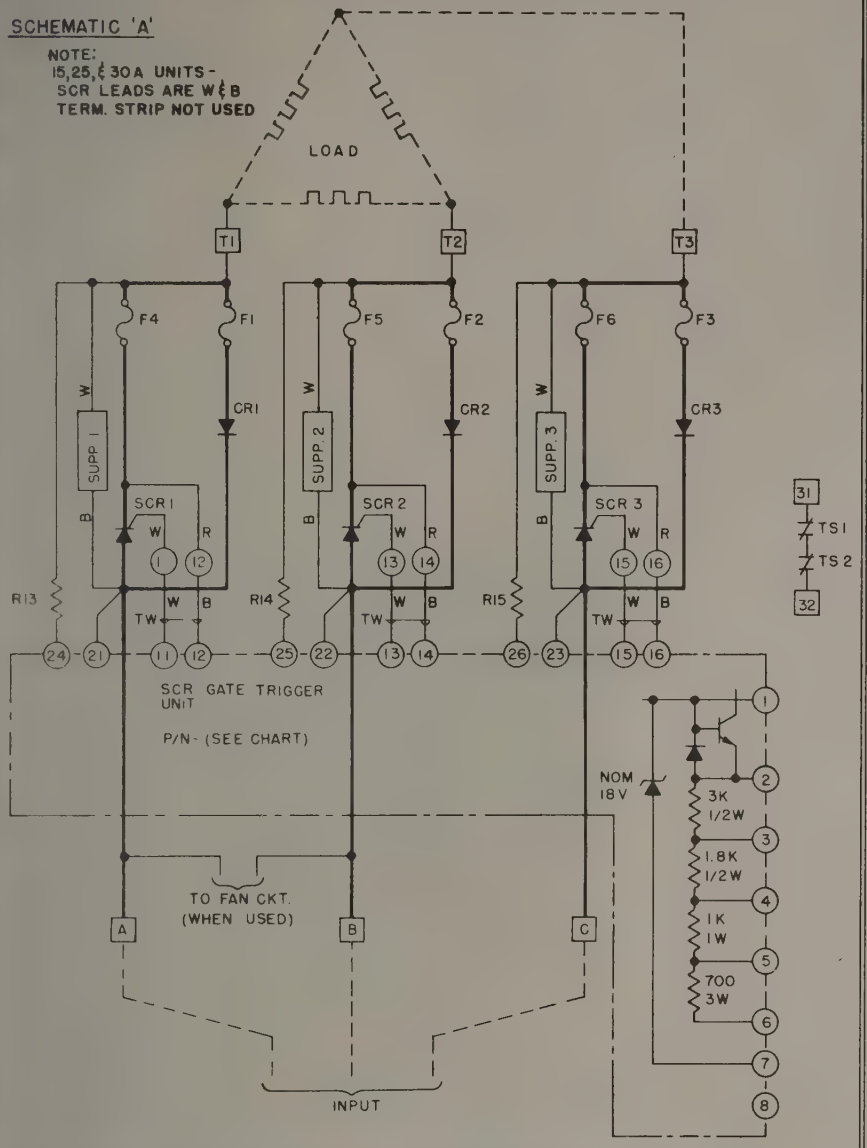
CONT SHT
SHT NO 2
DWG NO 401100
REV B

REPLACEMENT PARTS			
RECTOR	C1	FUSE	R9
DL880B	.1uF,3000V	KAC30	10K,50W
A40B(2)	.1uF,700V	A70P125	12K,50W

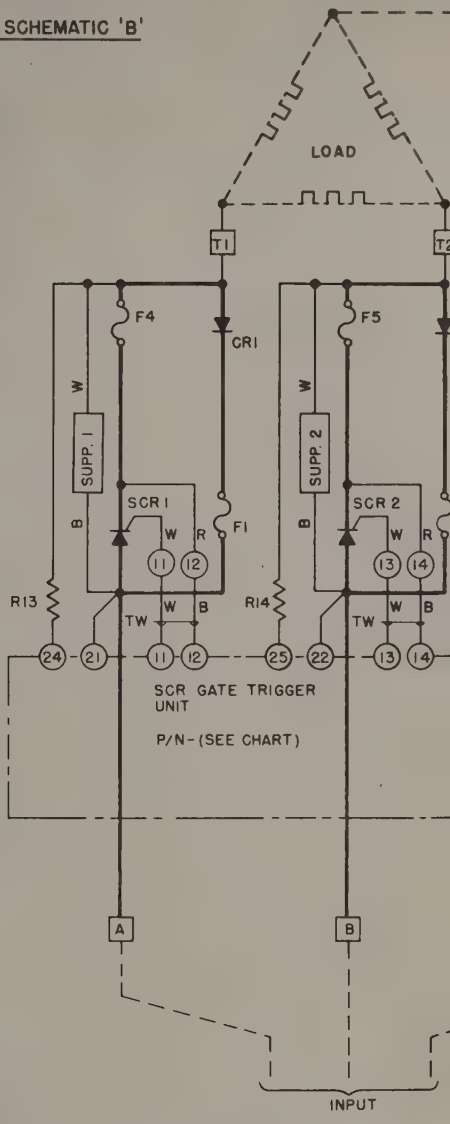
SCALE		Robicon Corporation A BARBER-COLMAN COMPANY	TITLE: SCR POWER CONTROLLER 401 INDUSTRIAL SERIES
DATE	6-10-77		
DRAWN	M.A.D.		
REVIEW	M.G.J.	CUSTOMER	DWG NO 401 100 REVISION B
CHECK			
APPROVE	R.E.K.	WORK ORDER STD.	CONT ON SHT — SHT NO 2

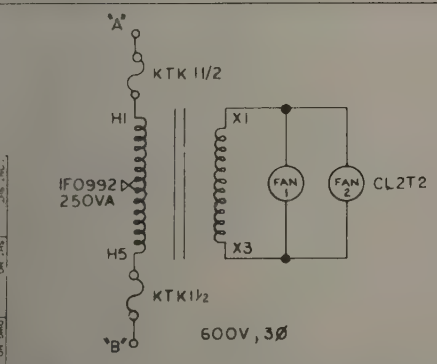
SCHEMATIC 'A'

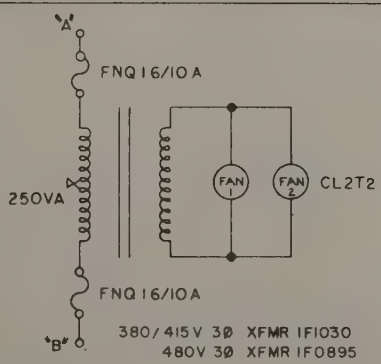
NOTE:
15,25,& 30A UNITS -
SCR LEADS ARE W & B
TERM. STRIP NOT USED

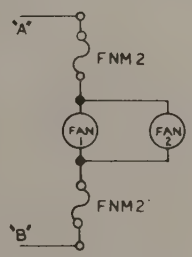


SCHEMATIC 'B'



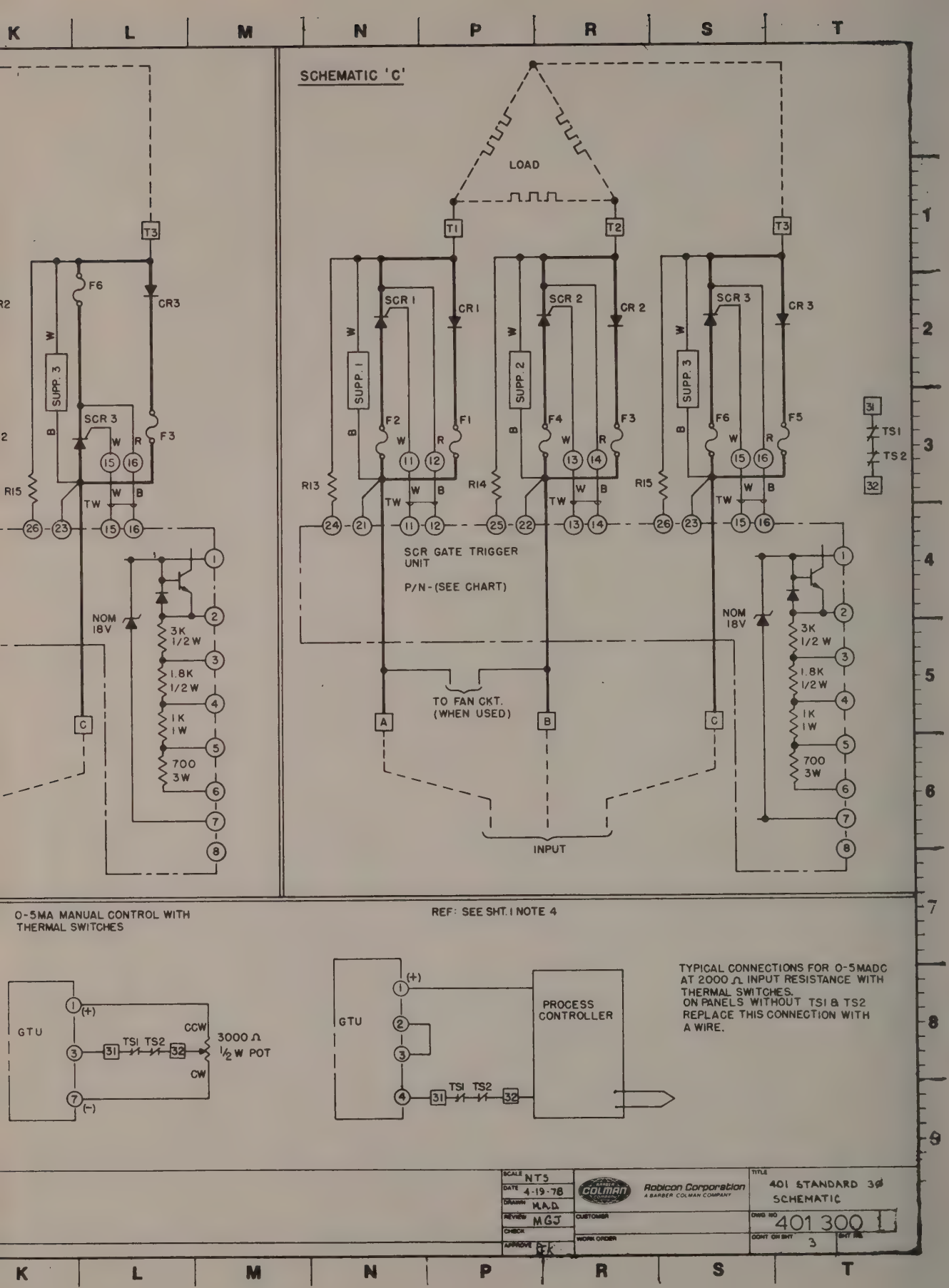






401 300

REVISIONS



0-5MA MANUAL CONTROL WITH THERMAL SWITCHES

REF: SEE SHT. 1 NOTE 4

TYPICAL CONNECTIONS FOR 0-5MADC AT 2000 Ω INPUT RESISTANCE WITH THERMAL SWITCHES.
ON PANELS WITHOUT TS1 & TS2 REPLACE THIS CONNECTION WITH A WIRE.

SCALE	NTS
DATE	4-19-78
DRAWN	M.A.D.
REVIEW	M.G.J.
CHECK	
APPROVE	
CUSTOMER	
WORK ORDER	

Rabicon Corporation
A BARBER COLMAN COMPANY

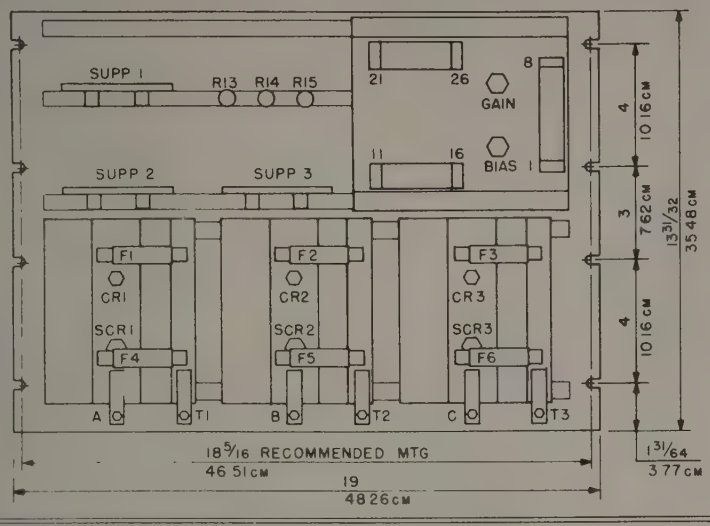
TITLE: 401 STANDARD 3Ø SCHEMATIC

DWG NO: 401 300 1

CONT ON SHT: 3

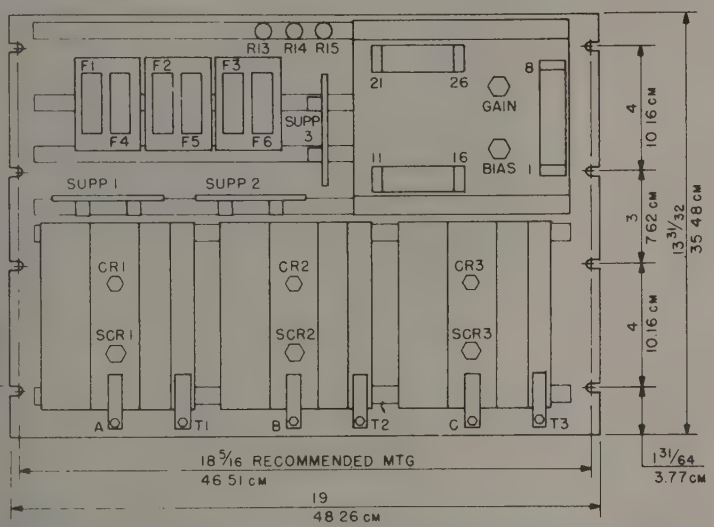
SHT NO:

FIG. 1
15/25 AMP



MAX HT
7 3/4
19.68 CM

FIG. 2
30 AMP



MAX HT
7 3/4
19.68 CM

FIG. 3
77 AMP

MAX HT
8
20.34 CM

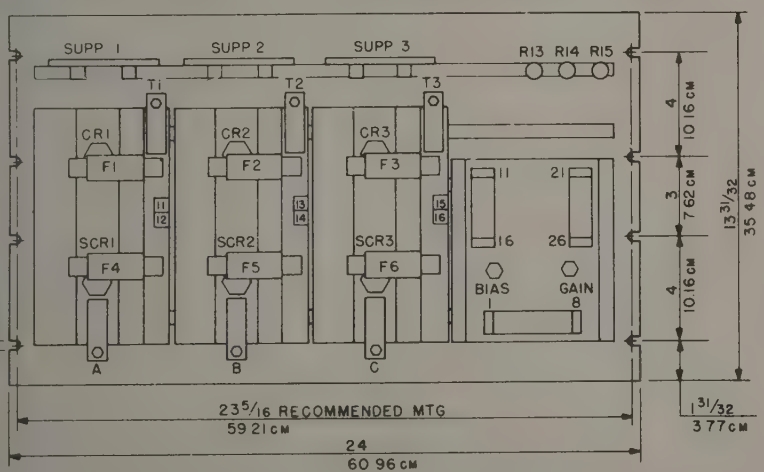
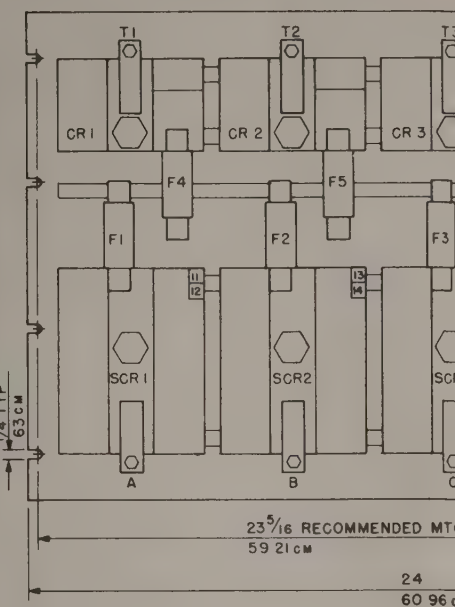
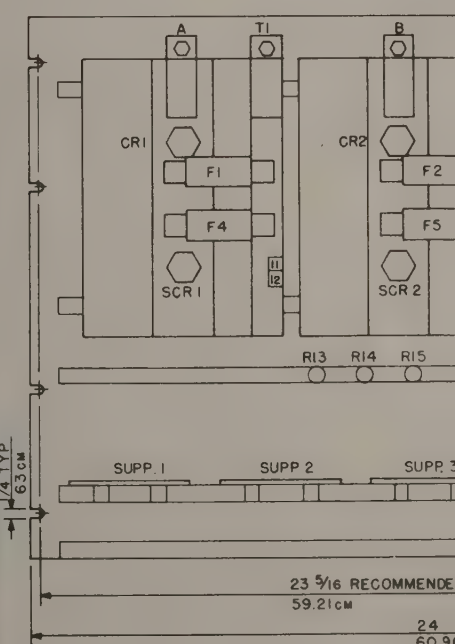


FIG. 4
110/154 AMP



MAX. HT
7 1/4
18.41 CM

FIG. 5
180/220 AMP



401300

REVISIONS

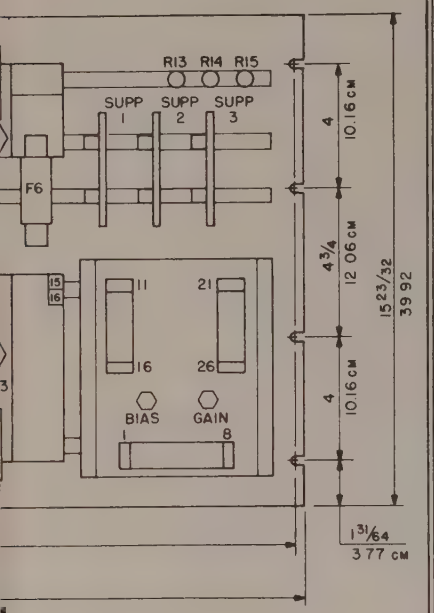
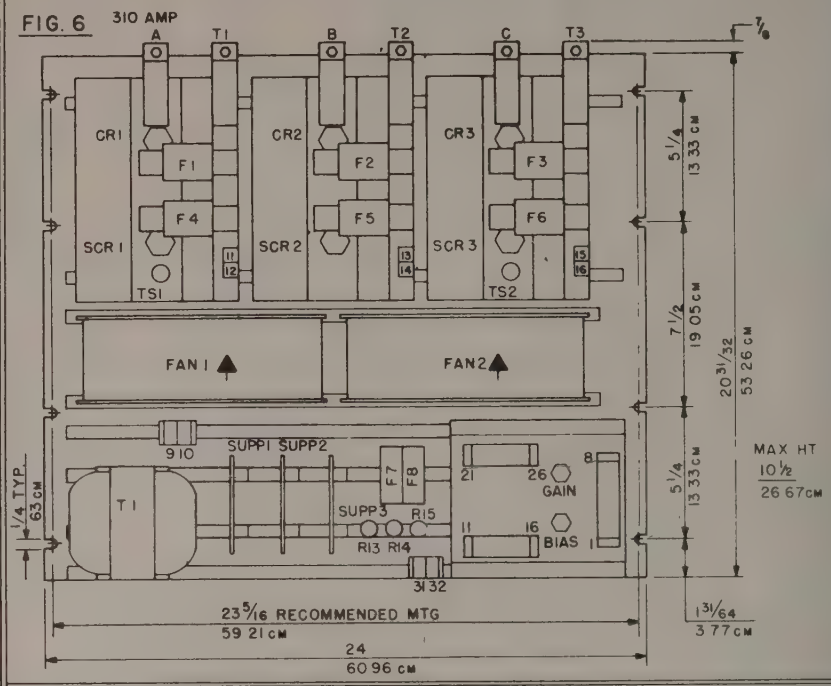


FIG. 6 310 AMP



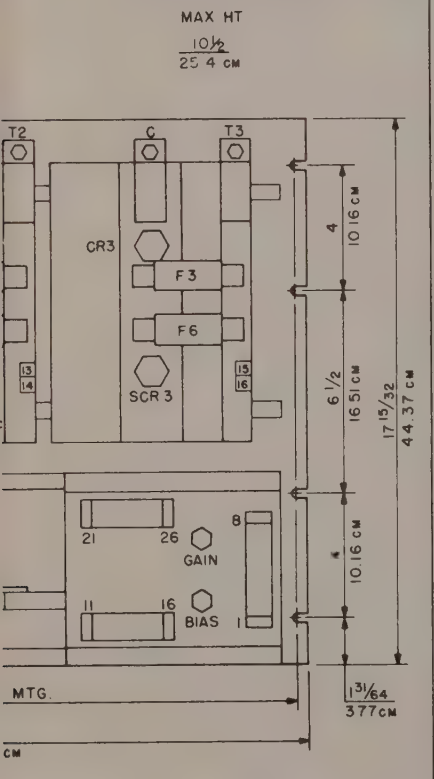
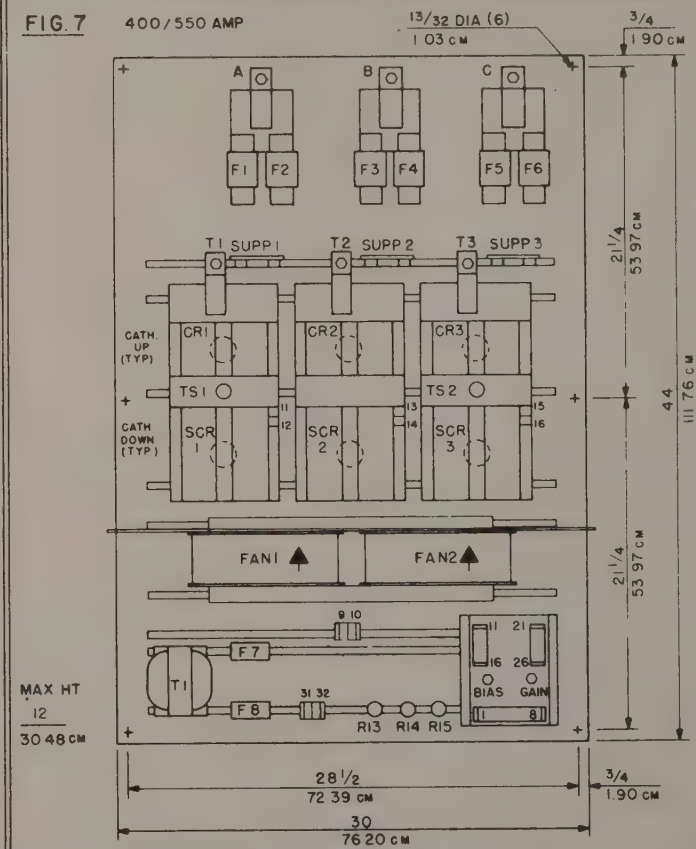


FIG. 7 400/550 AMP



NOTE: SEAL EDGES OF BAFFLE WHEN USED IN CABINET

SCALE N.T.S.	Colman / Robicon Corporation, A Barber Colman Company	TITLE 401 STANDARD 3 Ø (OUTLINES)	
DATE 8-3-78			
DRAWN M A D			
REVIEW M G J	CUSTOMER	DWG NO 401300	REVISION C
CHECK		CONT ON SHT ~	SHT NO 8
APPROVE [illegible]	WORK ORDER		

6. CURREN

THE
SET
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140
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XF1

7. INSTAL

THES
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AMBI

REVISIONS			
A	ADD CT'S & MOUNT HOLE FOR CT'S ADDED 2 WIRE JUMPER ADDED NOTE 8		
B	TO CHART 3 TAP & 3 TAP ADDED		
C	REV OVERALL DIM FOR 400A UNITS PER ECN 4-9-81 LAB		

401 800

SHEET NO. 1

CONT. SHT. 2

NOTES: FOR SERIES 401:

1. THE SERIES 401 SINGLE PHASE SCR POWER CONTROLLERS PROVIDE SOLID STATE PHASE ANGLE CONTROL OF AC POWER. THE SCR'S (THYRISTORS) SERVE AS SOLID STATE SWITCHES WHICH, WHEN CLOSED, APPLY LINE VOLTAGE TO THE LOAD. IN PHASE ANGLE CONTROL, EACH SCR IS TURNED ON FOR A CONTROLLED PORTION OF A HALF-CYCLE OF THE LINE VOLTAGE. THE EFFECTIVE VOLTAGE (HENCE POWER) IS DETERMINED BY THE PORTION OF THE LINE VOLTAGE DELIVERED. THE LOAD VOLTAGE CAN BE VARIED BY SELECTING THE FIRING TIME OF EACH SCR.

   THESE UNITS MAY BE OPERATED INTO RESISTIVE OR INDUCTIVE LOADS DRIVEN EITHER DIRECTLY OR THROUGH AN INTERPOSING TRANSFORMER OR VARIABLE AUTOTRANSFORMER.

   SPECIAL PRECAUTIONS ARE NECESSARY TO LIMIT PEAK INRUSH CURRENTS WHEN THESE UNITS ARE DRIVING CAPACITIVE OR TUNGSTEN LAMP LOADS. AN EXAMPLE OF THE FORMER TYPE OF LOAD IS A RECTIFIER BRIDGE WITH LARGE AMOUNTS OF FILTERING. SOME UNITS HAVE A 4 SECOND RAMP BUILT IN TO LIMIT THE RATE OF THE OUTPUT VOLTAGE TO PREVENT FIRING INTO A COLD LOAD. THESE UNITS ARE INTENDED FOR OPERATION INTO HIGH-INRUSH LOADS. REFER TO TABLE I FOR THE SPECIFIC UNIT.

2. POWER CONNECTIONS

   INPUT: REFER TO TABLE I FOR VOLTAGE AND CURRENT RATINGS. UNITS SHUT DOWN AUTOMATICALLY IF LINE VOLTAGE DROPS BELOW 70% OF NOMINAL VALUE. NORMAL OPERATION WILL RETURN WITH RECOVERY OF LINE VOLTAGE.

   CONNECT ONE SIDE OF THE LOAD TO T1. CONNECT ONE SIDE OF THE LINE TO L1. CONNECT THE OTHER SIDE OF THE LINE TO THE REMAINING SIDE OF THE LOAD AND RUN A SEPARATE LEAD FROM THIS JUNCTION TO SCREW TERMINAL L2. L2 IS USED FOR CONTROL PURPOSES ONLY.

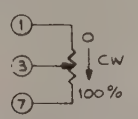
   OUTPUT: 0-96% OF LINE VOLTAGE. RMS CURRENTS LISTED ARE FOR CONTINUOUS OPERATION IN FREE AIR AT AMBIENT TEMPERATURES OF 50°C OR LESS. LINEARITY IS ±2% OF FULL OUTPUT VOLTAGE FROM 5% TO 96% OF THE INPUT VOLTAGE.

3. CONTROL INPUT CONNECTIONS:

   (A) AUTOMATIC CONTROL
   CONNECT POSITIVE TO TERM. 1.
   CONNECT NEGATIVE TO APPROPRIATE TERMINAL FOR AVAILABLE CONTROL INPUT SIGNAL.

INPUT CONNECTION	NEGATIVE INPUT TERMINAL	JUMPER	NOMINAL RANGE	INPUT RESISTANCE	MAX. ALLOWABLE CURRENT
A_{100}	2		0-5 MA	100 OHMS	20 MA
A_{3000}	3		1-5 MA	3000 OHMS	12 MA
A_{5000}	4		1-5 MA	5000 OHMS	12 MA
B	4	6 TO 1	4-20 MA	1200 OHMS	40 MA
C	5	6 TO 1	10-50 MA	600 OHMS	70 MA
D	3	6 TO 1	2-12 MA	1500 OHMS	27 MA

   (B) MANUAL CONTROL CONNECT 3000 OHM, 1/2W POTENTIOMETER AS FOLLOWS:



   OTHER INPUT RANGES AND INPUT RESISTANCE VALUES OBTAINABLE WITH COMBINATIONS OF INTERNAL AND/OR EXTERNAL RESISTORS. CONTROL MAY BE APPLIED OF OPPOSITE POLARITY AS SHOWN. IN ANY CASE, CURRENT THROUGH CONTROL WINDING MUST NOT EXCEED 20 MA.

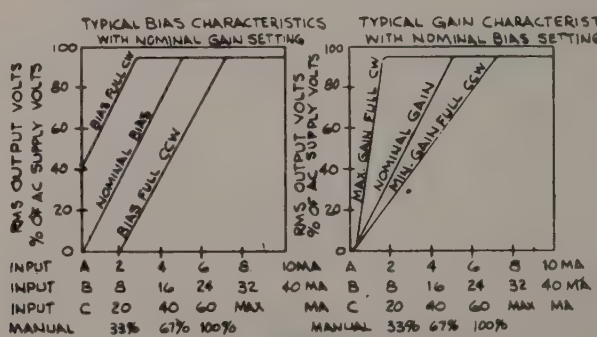
   (C) TERMINALS - #6-32 SCREW CONNECTION.

4. DIELECTRIC TEST VOLTAGES

CONTROL CIRCUIT TO GROUND	1000VAC
POWER CIRCUIT TO CONTROL CIRCUIT	2 x RATED + 1000VAC
POWER CIRCUIT TO GROUND	

5. GAIN AND BIAS CONTROLS

   GAIN AND BIAS ARE FACTORY SET AT NOMINAL SETTINGS AS INDICATED BELOW. (0-5 MA NOMINAL RANGE)


TYPICAL BIAS CHARACTERISTICS WITH NOMINAL GAIN SETTING
RMS OUTPUT VOLTS % OF AC SUPPLY VOLTS
100
80
60
40
20
0
BIAS FULL CW
NOMINAL BIAS
BIAS FULL CCW
INPUT A 2 4 6 8 10MA
INPUT B 8 16 24 32 40 MA
INPUT C 20 40 60 MAX MA
MANUAL 33% 67% 100%
TYPICAL GAIN CHARACTERISTICS WITH NOMINAL BIAS SETTING
RMS OUTPUT VOLTS % OF AC SUPPLY VOLTS
MAX. GAIN FULL CW
NOMINAL GAIN
MIN. GAIN FULL CCW
A 2 4 6 8 10 MA
B 8 16 24 32 40 MA
C 20 40 60 MAX MA
MANUAL 33% 67% 100%

T LIMIT OPTIONAL:

CURRENT LIMIT ADJUST POTENTIOMETER WILL BE FACTORY TO LIMIT THE CURRENT TO RATED VALUE. THE CURRENT T SET POINT IS ADJUSTABLE FROM ZERO TO APPROXIMATELY OF RATED CURRENT. IF THE CURRENT LIMIT SET POINT D BE DECREASED, TURN THE CURRENT LIMIT ADJUST NTIOMETER COUNTERCLOCKWISE. CONVERSELY, IF IT IS RED TO INCREASE THE CURRENT LIMIT SET POINT, TURN CURRENT LIMIT ADJUST POTENTIOMETER CLOCKWISE. AND CT1 ARE ONLY USED W/CL OPTION.

LATION PRECAUTIONS

E AIR COOLED PANELS ARE RATED FOR OPERATION IN ENTS OF 50°C (122°F) MAXIMUM. THEY SHOULD BE TED WITH HEATSINKS VERTICAL IN OPEN AIR SPACES HE PANELS ARE MOUNTED IN SPACES WITH RESTRICTED FLOW, PRECAUTIONS SHOULD BE TAKEN TO ENSURE AN ENT OF LESS THAN 50°C.

SCALE NTS	Robicon Corporation A BARBER COLMAN COMPANY	TITLE SCR PWR CONT NOTES 401 10Ø 310A-540A	
DATE 1-24-80			
DRAWN KJB			
REVIEW MGJ	CUSTOMER	DWG NO 401 800	REVISION C
CHECK	WORK ORDER	CONT ON SHT 2	SHT NO 1
APPROVE KB			

TABLE 1

P/N	VOLTS	AMPS	PRESSURE LUG* PWR. TERM. T1,L1	PWR. TERM. L2	REPLACEMENT PARTS W SCR	CH.-SH. FUSE	** E.I. CT1	** ROBICON CT2	ROBICON SUPP.	OHMITE R9	WO/CL -01,-21(*Hz)	WO/CL -11,-31(50Hz)
401 134	120	310	•2-600 MCM	8-32 SCREW	T620033004DN	A50P350	74-401	190 060	168 100-1	1.5K 2W	460 233-01	460 233-41
401 135	↓	400	500-1000 MCM	↓	T720035504DN	A50P450	74-401	↓	↓	↓	↓	↓
401 136	↓	540	600 MCM-2 (2)	↓	T9G0061203DH	A50P600	74-601	↓	↓	↓	↓	↓
401 634	208	310	•2-600 MCM	↓	T620053004DN	A50P350	74-401	↓	168 100-2	5K 12W	460 233-06	↓
401 635	↓	400	500-1000 MCM	↓	T720055504DN	A50P450	74-401	↓	↓	↓	↓	↓
401 636	↓	540	600 MCM-2 (2)	↓	T9G0061203DH	A50P600	74-601	↓	↓	↓	↓	↓
401 234	240	310	•2-600 MCM	↓	T620053004DN	A50P350	74-401	↓	↓	↓	460 233-02	460 233-42
401 235	↓	400	500-1000 MCM	↓	T720055504DN	A50P450	74-401	↓	↓	↓	↓	↓
401 236	↓	540	600 MCM-2 (2)	↓	T9G0061203DH	A50P600	74-601	↓	↓	↓	↓	↓
401 434	277	310	•2-600 MCM	↓	T620063004DN	A50P350	74-401	↓	168 100-3	↓	460 233-04	↓
401 435	↓	400	500-1000 MCM	↓	T720065504DN	A50P450	74-401	↓	↓	↓	↓	↓
401 436	↓	540	600 MCM-2 (2)	↓	T9G0061203DH	A50P600	74-601	↓	↓	↓	↓	↓
401 834	380	310	•2-600 MCM	↓	T620103004DN	A50P350	74-401	↓	168 100-4	10K 50W	↓	460 233-47
401 835	↓	400	500-1000 MCM	↓	T720105504DN	A50P450	74-401	↓	↓	↓	↓	↓
401 836	↓	540	600 MCM-2 (2)	↓	T9G0101203DH	A50P600	74-601	↓	↓	↓	↓	↓
401 834	415	310	•2-600 MCM	↓	T620103004DN	A50P350	74-401	↓	↓	↓	460 233-48	↓
401 835	↓	400	500-1000 MCM	↓	T720105504DN	A50P450	74-401	↓	↓	↓	↓	↓
401 836	↓	540	600 MCM-2 (2)	↓	T9G0101203DH	A50P600	74-601	↓	↓	↓	↓	↓
401 334	480	310	•2-600 MCM	↓	T620103004DN	A50P350	74-401	↓	↓	↓	460 233-03	↓
401 335	↓	400	500-1000 MCM	↓	T720105504DN	A50P450	74-401	↓	↓	↓	↓	↓
401 336	↓	540	600 MCM-2 (2)	↓	T9G0101203DH	A50P600	74-601	↓	↓	↓	↓	↓
401 534	600	310	•2-600 MCM	↓	T620123004DN	A70P350	74-401	↓	168 100-5	12K 50W	460 233-05	↓
401 535	↓	400	500-1000 MCM	↓	T720125504DN	A70P450	74-401	↓	↓	↓	↓	↓
401 536	↓	540	600 MCM-2 (2)	↓	T9G0121203DH	A70P600	74-601	↓	↓	↓	↓	↓

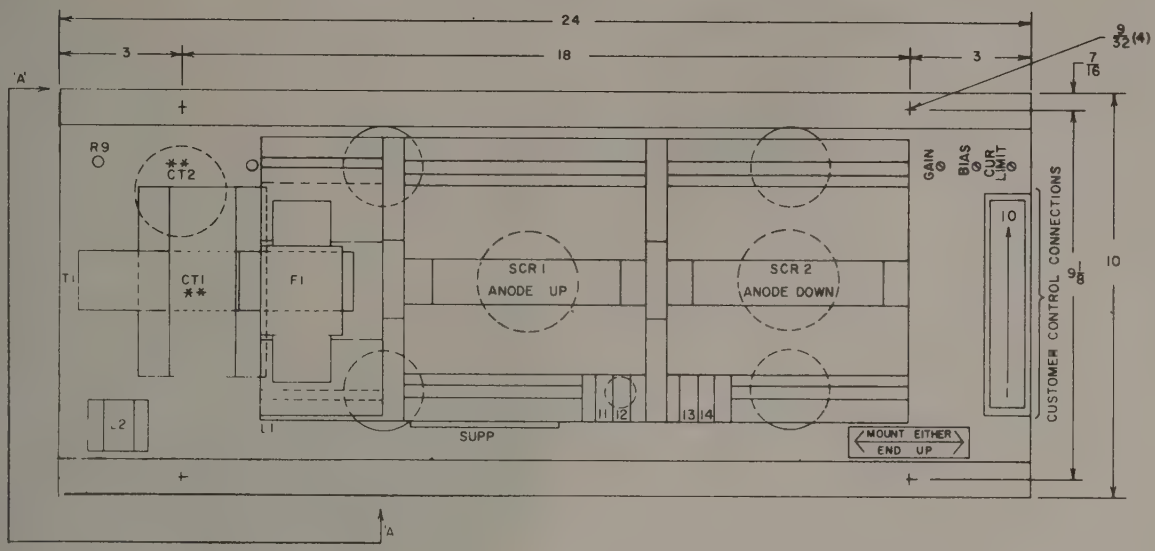
ROBICON GTU

W/CL -02,-22(*Hz)	W/CL -12,-32(50Hz)	WO/CL LONG RAMP -05,-25(*Hz)	WO/CL LONG RAMP -15,-35(50Hz)	W/CL LONG RAMP -06,-26(*Hz)	W/CL LONG RAMP -16,-36(50Hz)	WO/CL FAST RAMP -07,-27(*Hz)	WO/CL FAST RAMP -17,-37(50Hz)	W/CL FAST RAMP -08,-28(*Hz)	W/CL FAST RAMP -18,-38(50Hz)
460 234-01	460 234-41	460 233-11	460 233-19	460 234-11	460 234-19	460 233-21	460 233-29	460 234-21	460 234-29
460 234-06		460 233-16		460 234-16		460 233-26		460 234-26	
460 234-02	460 234-42	460 233-12	460 233-35	460 234-12	460 234-35	460 233-22	460 233-10	460 234-22	460 234-10
460 234-04		460 233-14		460 234-14		460 233-24		460 234-24	
	460 234-47		460 233-17		460 234-17		460 233-27		460 234-27
460 234-48		460 233-18		460 234-18		460 233-28		460 234-28	
460 234-03		460 233-13		460 234-13		460 233-23		460 234-23	
460 234-05		460 233-15		460 234-15		460 233-25		460 234-25	

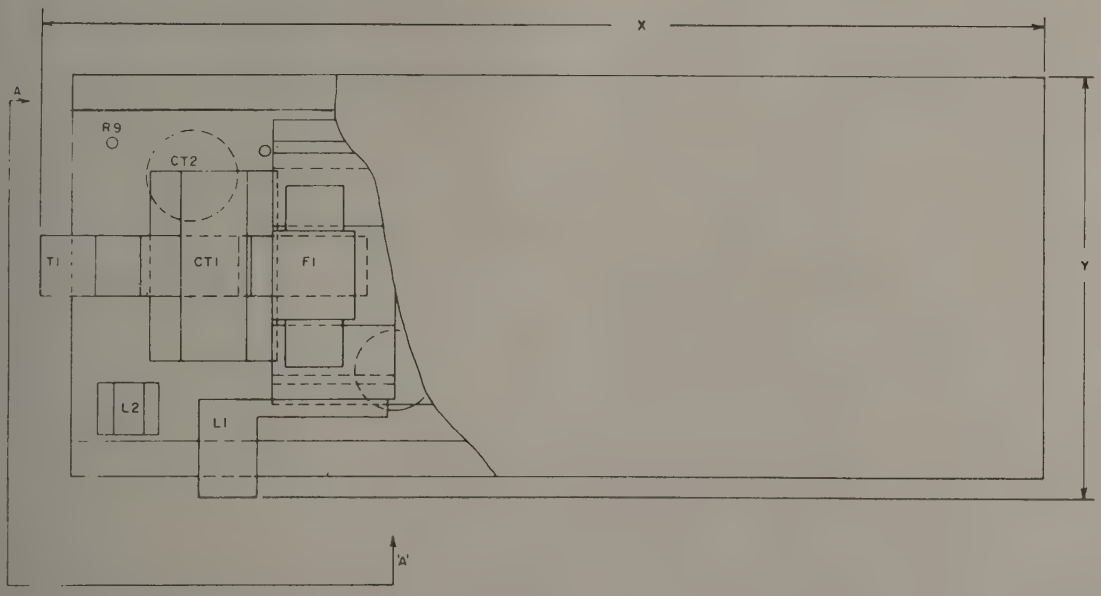
NOTES (FOR TABLE):

1. ** INDICATES PARTS THAT ARE USED ON UNITS WITH CURRENT LIMIT (W/CL) ONLY.
   A. WO/CL = WITHOUT CURRENT LIMIT
   B. W/CL = WITH CURRENT LIMIT
2. DASH NO.'S
   A. -1,-2,-5,-6,-7,-8,-21,-22,-25,-26,-27,-28 ARE 60 Hz, EXCEPT FOR 415V WHICH IS 50 Hz.(*)
   B. -11,-12,-15,-16,-17,-18,-31,-32,-35,-36,-37,-38 ARE 50 Hz, EXCEPT FOR 415V (SEE 2A ABOVE).
   C. -21,-22,-25,-26,-27,-28,-31,-32,-35,-36,-37,-38 ARE UNITS WITHOUT CONNECTORS.
3. SPECIALS - -20 THRU -99 ARE SPECIALS. 415V & 380V, 60 Hz UNITS AND OTHER SPECIALS, SEE TABLE 2, SHEET 4. ADD INCREMENTS OF 20 TO DASH NO. FOR SPECIAL, BASED ON GTU REQUIREMENTS.
4. WIRE CONNECTIONS TO PWR. TERM. T1 & L1 TO BE COPPER ONLY.

SCALE NTS	COLMAN Robicon Corporation A BARBER-COLMAN COMPANY	TITLE SCR PWR. CONT. TABLE I 40110 310A-540A	
DATE 1-17-80			
DRAWN KJB			
REVIEW MGJ	CUSTOMER	DWG. NO 401 800	REVISION C
CHECK		CONT. ON SHT 3	SHT. NO. 2
APPROVE KB	WORK ORDER		



DEPTH 13 1/2



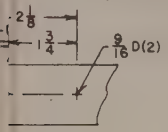
OVERALL DIMENS

AMPS	X
310A	24
400A	24
540A	24

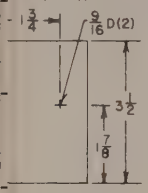
REVISIONS

401 800

FOR 310,400,&540A UNITS

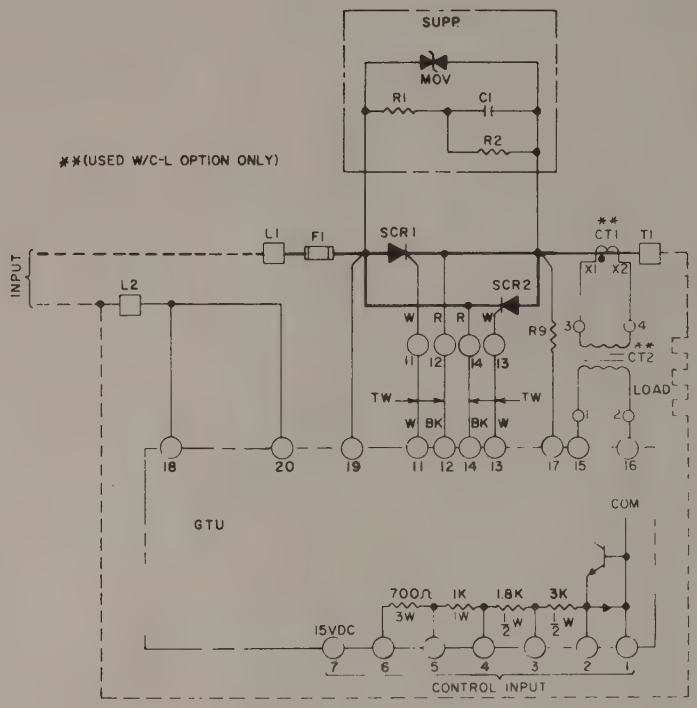


&540A UNITS

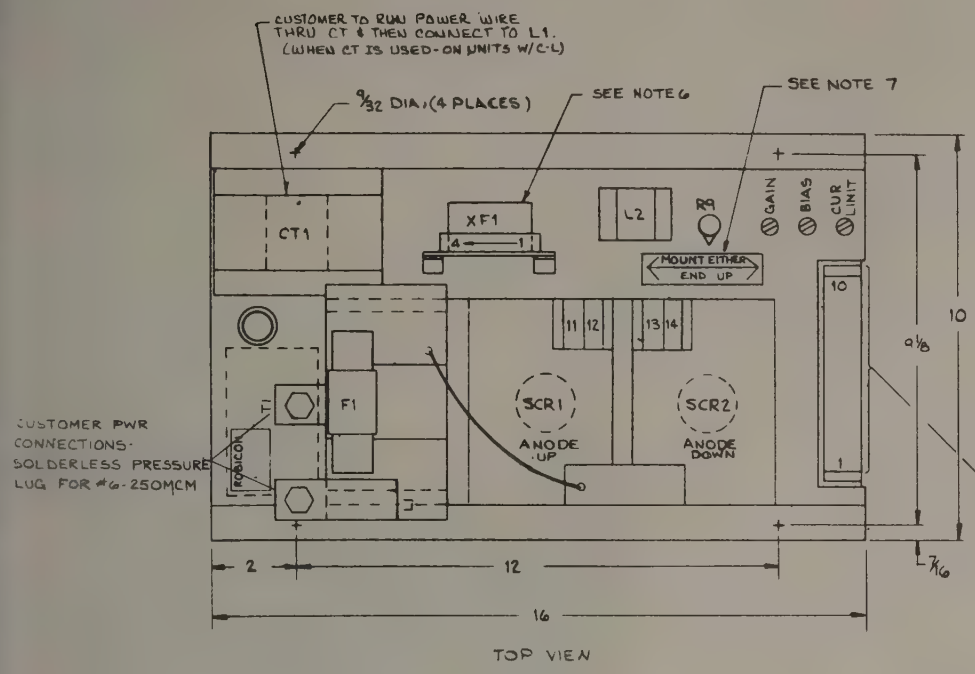


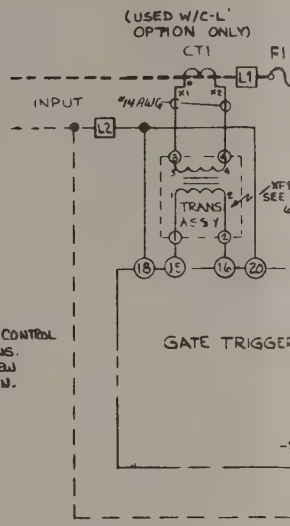
IONS W/CONNECTORS

	Y
	10 1/8
	10 1/4
	10 1/8



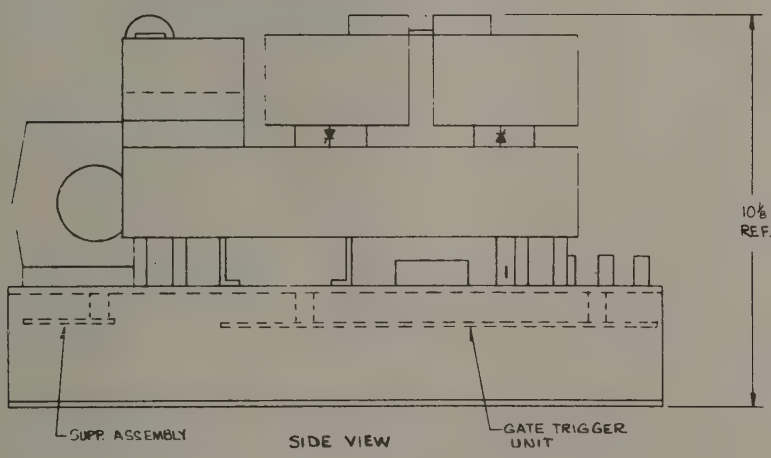
SCALE 1/2 = 1	Robicon Corporation	TITLE SCR PWR CONT OUTLINE, SCHEMATIC 401 1@ 310A-540A	
DATE 1-10-80			
DRAWN KJB			
REVIEW MGJ	CUSTOMER	DWG NO 401 800	REVISION C
CHECK		CONT ON SHT ~	SHT NO 3
APPROVE KB	WORK ORDER		



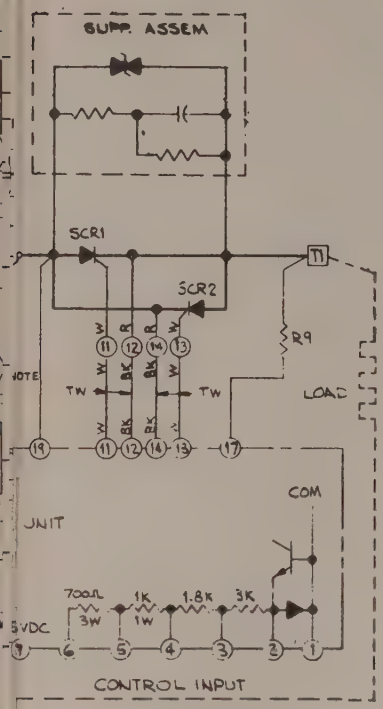


6. C

7. I



REVISIONS		
A	ADDED POWER WIRE NO. MKT'T	
	XF1 TERM. NOS. ADDED	
B	ADDED WIRE SIZE TO CT1 YDL 4-10-78 JAW 4-11-78	
C	UPDATED DWG. (TABLE I ADDED TABLE II W/S TERM. SIZE C)	
D	PER ECN 1446 ECR 3574 REV'D 3-6-80 RC	



NOTES: FOR SERIES 401:

1. THE SERIES 401 SINGLE PHASE SCR POWER CONTROLLERS PROVIDE SOLID STATE PHASE ANGLE CONTROL OF AC POWER. THE SCR'S (THYRISTORS) SERVE AS SOLID STATE SWITCHES WHICH, WHEN CLOSED, APPLY LINE VOLTAGE TO THE LOAD. IN PHASE ANGLE CONTROL, EACH SCR IS TURNED ON FOR A CONTROLLED PORTION OF A HALF-CYCLE OF THE LINE VOLTAGE. THE EFFECTIVE VOLTAGE (HENCE POWER) IS DETERMINED BY THE PORTION OF THE LINE VOLTAGE DELIVERED. THE LOAD VOLTAGE CAN BE VARIED BY SELECTING THE FIRING TIME OF EACH SCR.

   THESE UNITS MAY BE OPERATED INTO RESISTIVE OR INDUCTIVE LOADS DRIVEN EITHER DIRECTLY OR THROUGH AN INTERPOSING TRANSFORMER OR VARIABLE AUTOTRANSFORMER.

   SPECIAL PRECAUTIONS ARE NECESSARY TO LIMIT PEAK INRUSH CURRENTS WHEN THESE UNITS ARE DRIVING CAPACITIVE OR TUNGSTEN LAMP LOADS. AN EXAMPLE OF THE FORMER TYPE OF LOAD IS A RECTIFIER BRIDGE WITH LARGE AMOUNTS OF FILTERING. SOME UNITS HAVE A 4 SECOND RAMP BUILT IN TO LIMIT THE RATE OF THE OUTPUT VOLTAGE TO PREVENT FIRING INTO A COLD LOAD. THESE UNITS ARE INTENDED FOR OPERATION INTO HIGH-INRUSH LOADS. REFER TO TABLE I FOR THE SPECIFIC UNIT.

2. POWER CONNECTIONS

   INPUT: REFER TO TABLE I FOR VOLTAGE AND CURRENT RATINGS. UNITS SHUT DOWN AUTOMATICALLY IF LINE VOLTAGE DROPS BELOW 70% OF NOMINAL VALUE. NORMAL OPERATION WILL RETURN WITH RECOVERY OF LINE VOLTAGE.

   CONNECT ONE SIDE OF THE LOAD TO T1. CONNECT ONE SIDE OF THE LINE TO L1. CONNECT THE OTHER SIDE OF THE LINE TO THE REMAINING SIDE OF THE LOAD AND RUN A SEPARATE LEAD FROM THIS JUNCTION TO SCREW TERMINAL L2. L2 IS USED FOR CONTROL PURPOSES ONLY.

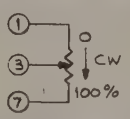
   OUTPUT: 0-96% OF LINE VOLTAGE. RMS CURRENTS LISTED ARE FOR CONTINUOUS OPERATION IN FREE AIR AT AMBIENT TEMPERATURES OF 50°C OR LESS. LINEARITY IS ±2% OF FULL OUTPUT VOLTAGE FROM 5% TO 96% OF THE INPUT VOLTAGE.

3. CONTROL INPUT CONNECTIONS:

   (A) AUTOMATIC CONTROL.
   CONNECT POSITIVE TO TERM. 1.
   CONNECT NEGATIVE TO APPROPRIATE TERMINAL FOR AVAILABLE CONTROL INPUT SIGNAL.

INPUT CONNECTION	NEGATIVE INPUT TERMINAL	JUMPER	NOMINAL RANGE	INPUT RESISTANCE	MAX. ALLOWABLE CURRENT
A_{100}	2		0-5 MA	100 OHMS	20 MA
A_{3000}	3		1-5 MA	3000 OHMS	12 MA
A_{5000}	4		1-5 MA	5000 OHMS	12 MA
B	4	6 TO 1	4-20 MA	1200 OHMS	40 MA
C	5	6 TO 1	10-50 MA	600 OHMS	70 MA
D	3	6 TO 1	2-12 MA	1500 OHMS	27 MA

   (B) MANUAL CONTROL CONNECT 3000 OHM, 1/2W POTENTIOMETER AS FOLLOWS:



   OTHER INPUT RANGES AND INPUT RESISTANCE VALUES OBTAINABLE WITH COMBINATIONS OF INTERNAL AND/OR EXTERNAL RESISTORS. CONTROL MAY BE APPLIED OF OPPOSITE POLARITY AS SHOWN. IN ANY CASE, CURRENT THROUGH CONTROL WINDING MUST NOT EXCEED 20 MA.

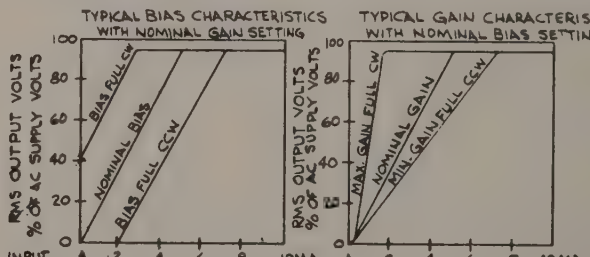
   (C) TERMINALS - #6-32 SCREW CONNECTION.

4. DIELECTRIC TEST VOLTAGES

CONTROL CIRCUIT TO GROUND	1000VAC
POWER CIRCUIT TO CONTROL CIRCUIT POWER CIRCUIT TO GROUND	2 x RATED + 1000 VAC

5. GAIN AND BIAS CONTROLS

   GAIN AND BIAS ARE FACTORY SET AT NOMINAL SETTINGS AS INDICATED BELOW. (0-5 MA NOMINAL RANGE)



CURRENT LIMIT OPTIONAL:

THE CURRENT LIMIT ADJUST POTENTIOMETER WILL BE FACTORY SET TO LIMIT THE CURRENT TO RATED VALUE. THE CURRENT LIMIT SET POINT IS ADJUSTABLE FROM ZERO TO APPROXIMATELY 140% OF RATED CURRENT. IF THE CURRENT LIMIT SET POINT IS TO BE DECREASED, TURN THE CURRENT LIMIT ADJUST POTENTIOMETER COUNTERCLOCKWISE. CONVERSELY, IF IT IS DESIRED TO INCREASE THE CURRENT LIMIT SET POINT, TURN THE CURRENT LIMIT ADJUST POTENTIOMETER CLOCKWISE. XF1 AND CT1 ARE ONLY USED W/CL OPTION.

INSTALLATION PRECAUTIONS:

THESE AIR COOLED PANELS ARE RATED FOR OPERATION IN AMBIENTS OF 50°C (122°F) MAXIMUM. THEY SHOULD BE MOUNTED WITH HEATSINKS VERTICAL IN OPEN AIR SPACES. IF THE PANELS ARE MOUNTED IN SPACES WITH RESTRICTED AIR FLOW, PRECAUTIONS SHOULD BE TAKEN TO ENSURE AN AMBIENT OF LESS THAN 50°C.

SCALE ½"=1"	COLMAN Rabicon Corporation A BARBER-COLMAN COMPANY	TITLE	SCR POWER CONTROLLER OUTLINE, SCHEM. & NOTES, 401 SERIES 10 130-220	
DATE 5-23-77		DWG NO	401880	REV D
DRAWN M.A.D.				
REVIEW MGT				
CHECK				
APPROVED		SHEET 2		

TABLE 1

P/N	INPUT VOLT	CURRENT	W SCR	E-I CT **	CH.-SH. FUSE	ROBICON SUPP.ASS'Y.	OHM R9	SEE NOTE 6 ROBICON XF1 **	W/O CL -01(*HZ)	W/O CL -11(50HZ)	W/CL -02(*
401 147	120	130	T620031304DN	64151	A25X150	168 100-01	1.5K,2W	168 139-00	460 233-01	460 233-41	460 234
401 148	↓	160	T620032004DN	64201	A25X200	↓	↓	↓	↓	↓	↓
401 149		190	T620033004DN	64201	A25X250						
401 150		220	T720034504DN	64251	A25X250						
401 647	208	130	T620051304DN	64151	A25X150	168 100-02	5K,12W		460 233-06	—	460 234
401 648	↓	160	T620052004DN	64201	A25X200	↓	↓		↓		↓
401 649		190	T620053004DN	64201	A25X250						
401 650		220	T720054504DN	64251	A25X250						
401 247	240	130	T620051304DN	64151	A25X150				460 233-02	460 233-42	460 234
401 248	↓	160	T620052004DN	64201	A25X200				↓	↓	↓
401 249		190	T620053004DN	64201	A25X250						
401 250		220	T720054504DN	64251	A25X250						
401 447	277	130	T620061304DN	64151	A50P150	168 100-03			460 233-04	—	460 234
401 448	↓	160	T620062004DN	64201	A50P200	↓			↓		↓
401 449		190	T620063004DN	64201	A50P250						
401 450		220	T720064504DN	64251	A50P250						
401 847	380	130	T620101304DN	64151	A50P150	168 100-04	10K,50W		—	460 233-47	—
401 848	↓	160	T620102004DN	64201	A50P200	↓	↓			↓	
401 849		190	T620103004DN	64201	A50P250						
401 850		220	T720104504DN	64251	A50P250						
401 847	415	130	T620101304DN	64151	A50P150				460 233-48	—	460 234
401 848	↓	160	T620102004DN	64201	A50P200				↓		↓
401 849		190	T620103004DN	64201	A50P250						
401 850		220	T720104504DN	64251	A50P250						
401 347	480	130	T620101304DN	64151	A50P150				460 233-03	—	460 234
401 348	↓	160	T620102004DN	64201	A50P200				↓		↓
401 349		190	T620103004DN	64201	A50P250						
401 350		220	T720104504DN	64251	A50P250						
401 547	600	130	T620121304DN	64151	A70P150	168 100-05	12K,50W		460 233-05	—	460 234
401 548	↓	160	T620122004DN	64201	A70P200	↓	↓		↓		↓
401 549		190	T620123004DN	64201	A70P250						
401 550		220	T720124504DN	64251	A70P250						

REPLACEMENT PARTS

	ROBICON GTU								
Z)	W/CL -12(50HZ)	WO/CL LONG RAMP -05(*HZ)	WO/CL LONG RAMP -15(50HZ)	W/CL LONG RAMP -06(*HZ)	W/CL LONG RAMP -16(50HZ)	WO/CL FAST RAMP -07(*HZ)	WO/CL FAST RAMP -17(50HZ)	W/CL FAST RAMP -08(*HZ)	W/CL FAST RAMP -18(50HZ)
-01	460 234-41 ↓	460 233-11 ↓	460 233-19 ↓	460 234-11 ↓	460 234-19 ↓	460 233-21 ↓	460 233-29 ↓	460 234-21 ↓	460 234-29 ↓
-06	—	460 233-16 ↓	—	460 234-16 ↓	—	460 233-26 ↓	—	460 234-26 ↓	—
-02	460 234-42 ↓	460 233-12 ↓	460 233-35 ↓	460 234-12 ↓	460 234-35 ↓	460 233-22 ↓	460 233-10 ↓	460 234-22 ↓	460 234-10 ↓
-04	—	460 233-14 ↓	—	460 234-14 ↓	—	460 233-24 ↓	—	460 234-24 ↓	—
	460 234-47 ↓	—	460 233-17 ↓	—	460 234-17 ↓	—	460 233-27 ↓	—	460 234-27 ↓
-48	—	460 233-18 ↓	—	460 234-18 ↓	—	460 233-28 ↓	—	460 234-28 ↓	—
-03	—	460 233-13 ↓	—	460 234-13 ↓	—	460 233-23 ↓	—	460 234-23 ↓	—
-05	—	460 233-15 ↓	—	460 234-15 ↓	—	460 233-25 ↓	—	460 234-25 ↓	—

NOTES (FOR TABLE):

1. ** INDICATES PARTS THAT ARE USED ON UNITS WITH CURRENT LIMIT (W/CL) ONLY.

   A. WO/CL = WITHOUT CURRENT LIMIT

   B. W/CL = WITH CURRENT LIMIT

2. DASH NO.'S

   A. -1,-2,-5,-6,-7,-8 ARE 60 Hz, EXCEPT FOR 415V WHICH IS 50 Hz.(*)

   B. -11,-12,-15,-16,-17,-18 ARE 50 Hz, EXCEPT FOR 415V (SEE 2A, ABOVE).

3. SPECIALS - -20 THRU -99 ARE SPECIALS. 415V & 380V, 60 Hz UNITS AND OTHER SPECIALS, SEE TABLE 2, SHEET 3. ADD INCREMENTS OF 20 TO DASH NO. FOR SPECIAL, BASED ON GTU REQUIREMENTS.

   I.E., A 480V, 60 Hz UNIT W/CL & THERMAL SW. IS -22.

   -40 THRU -59 ARE RESERVED FOR UNITS IN ENCLOSURES. ADD 40 TO DASH NO. FOR UNIT PART NO.

   I.E., A -1 IN ENCLOSURE WOULD BE A -41; A -8 WOULD BE A -48.

   ENCLOSURES ARE ALL NEMA 1 24 x 24 x 12 WITH LOUVERS (380 205-1).

SCALE NTS	Robicon Corporation A BARBER-COLMAN COMPANY	TITLE SCR PWR CONT TABLE I 401 1Ø 130A - 220A	
DATE 1-17-80			
DRAWN KJB			
REVIEW MGJ	CUSTOMER	DWG NO 401880	REVISION D
CHECK			
APPROVE KB	WORK ORDER	CONT ON SHT 3	SHT NO 2

TABLE 2

P/N	INPUT VOLTS	CURRENT	REPLACEMEN								
			SCR	E-I CT2 **	CH.-SH. FUSE	ROBICON SUPP.	OHM. R9	SEE NOTE 6 ROBICON XF1 **	WO/CL -21(*HZ)	WO/CL -31(50HZ)	W -22
401 348	480	160	T620122004DN	64201	A50P200	168 100-4	10K50W	168 139-00	——	——	460

REVISIONS

PARTS										
	ROBICON GTU									
CL *HZ)	W/CL -32(50HZ)	WO/CL LG.RP. -25(*HZ)	WO/CL LG.RP. -35(50HZ)	W/CL LG.RP. -26(*HZ)	W/CL LG.RP. -36(50HZ)	WO/CL FAST RP. -27(*HZ)	WO/CL FAST RP. -37(50HZ)	W/CL FAST RP. -28(*HZ)	W/CL FAST RP. -38(60HZ)	COMMENTS
234-3	——	——	——	——	——	——	——	——	——	USES TS1 100°C NO

SCALE NTS	Robicon Corporation A BARBER COLMAN COMPANY	TITLE SCR PWR CONT TABLE 2 40110 130A-220A		
DATE 1-17-80				
DRAWN KJB				
REVIEW MGJ	CUSTOMER	DWG NO 401 880	REVISION D	
CHECK				
APPROVE KB	WORK ORDER	CONT ON SHT ~	SHT NO 3	

MP MASTER
MA32126